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BRITISH FOUNDRYMEN'S ASSOCIATION.
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NOTES AND COMMENTS.

Good Progress.

We once more have the pleasure of congratulating the British Foundrymen's Association on a very successful gathering for the conclusion of the year's work and the initiation of a new session's efforts. The Convention at Cardiff last month was pronounced by all to be a very successful gathering, and a perusal of the proceedings as recorded in this issue of our paper will confirm that. It is worthy of note that several of the Papers presented were of an eminently practical character and evoked considerable interest; from which it will be seen that the Association, while necessarily pushing the scientific aspects of foundry work, does not neglect to maintain the association between science and practice which is the basis of successful founding. The work of the local Branches of the Association during the past year has been very good, and earnest appreciation of the help given and the educational influence exerted is expressed on every hand. The retiring President has reason to experience considerable satisfaction at the progress made during his term of office, for not only has the membership reached the excellent figure of 900, but the influence and importance of the Association is increasing steadily. The new President may be fairly expected to maintain this progress, for he, in conjunction with the other officers of Association, has been largely responsible for past progress. We would impress upon each individual member, however, the necessity of doing all possible to bring the objects of the Association before employers and fellow-workers alike. It is not sufficient to have good organisation at headquarters—it is necessary for each to be a worker and spread the gospel of foundry education at all times. Further, not only the more advanced and progressive foundrymen must be brought in; the young fellows on whom we must rely in the course of a few years must also be taught the relationship between education and progress.

The Apprentice.

The importance of the subject is sufficient excuse for reverting again to the Paper and discussion on the training of foundry apprentices, which formed an important feature of the Cardiff programme. The subject may be considered from two standpoints: (1) that of improving the class of lad attracted to the foundry, i.e., improving the prospects of the calling without reference to any improvement in the class in general from which the boys are now drawn, or (2) that of raising the educational and intellectual status of the classes which now supply the trade with its young workers. The former is probably the easiest problem to attack; but it is not the one which will ultimately be for the benefit of the country. It appears to us that the essence of the problem lies not so much in definite technical instruction in any specific trade as in the general development of the intellectual powers of the boy from the age of 14 to about 18. It should not be

overlooked that the average student never thoroughly learns even the simplest lesson until he has applied it practically. There are, indeed, few intelligences capable of acquiring and storing abstract information until it has a practical association; and for this reason much that is learned in the elementary school is forgotten and has to be practically re-learned when it is needed. But, unfortunately, many of our present systems do not take into consideration that important period during which early schooling is brought into touch with its application; and the result is that a large proportion of boys do not receive the necessary supervision and stimulus at the time when they best might permanently acquire knowledge, *i.e.*, the first few years of entering their trade and calling. It is difficult to discuss the question of youthful training without admitting directly that any adequate scheme should cover not only the foundry trade, but every other trade or calling, including even what is very often erroneously termed "unskilled labour." A fact too often overlooked in considering the question of education for the individual worker is that the value and efficiency of the working community at large is really that of the aggregate of its individual members. There is a tendency in some quarters to believe that unskilled labour, providing that it can be so far trained as to perform certain operations fairly successfully, is the cheapest form of labour. As a matter of fact, it is usually the dearest, for while skilled labour may demand and obtain increased payment, the resulting output value justifies the outlay, and it should only be too obvious that a well-trained and efficient community is a greater asset to the country than an efficient one working at a low wage.

At the moment, however, the question in point is the training of young foundry workers, and while it might be admitted that a proper national scheme of education would solve the difficulty for the foundry, such a scheme is not in view, and the trade must handle its own problem first. The thorough reformer is often averse to purely local treatment, as being superfluous, if the basis problem is attacked. But so far as the foundry is concerned, local treatment is certainly necessary now; and it has yet to be proved that there are not features of the foundry's trouble that would be left untouched by a general educational scheme. The estimation in which the trade is held must be raised commensurate with its importance; and also the standard of intelligence of the workers as a whole must be raised. The former, we think, will be a natural accompaniment of the latter. A great difficulty in the education of most of the youths who pass out to other than some of the higher branches of the engineering and similar trades, is that they commence performing routine operations before the intelligence is developed to the point of understanding the relationship between the process in question and the trade of which it forms part, and also the relationship between the individual as a worker and the efficiency of the plant as a whole; consequently a better general education at the period of greatest mental development—14 to 18—should be the basis of any educational reform. We may here revert to the objection raised by one speaker at Cardiff, to the suggested "half-time" system (half of the apprentice's time being spent in the works and half at continued schooling related to his work). The objection was that the supply of apprentices would thus be reduced to one-half, so far as shop operations were concerned; or, alternately, that if the shop's demands were met, the supply of apprentices under training would be double the requirements of the trade. That objection, since it is presumably based on the assumption that a large proportion of the foundry's work is only suitable for boy labour, must fall to the ground; for if such were foundry conditions the deficiency of skilled labour would not have become a problem. As a matter of fact, the effect of a "half-time" system would be to increase the expense of employing apprentices in the shop (though, of course, giving more efficient workmen ultimately), and this would mean that half the operations now performed by boys would fall to older men. It is unfortunate that individual firms attempting to initiate a movement in this direction would thus have to bear considerable expense, and under highly-competitive conditions firms who rely largely on that class of labour would stand a great risk of extinction, should they set out to eliminate at once that which is unskilled, uneducated and low-paid. These are some of the difficulties which operate against spontaneous movements towards education; and for this reason it is far easier to conceive a reform in education and technical training on a national basis than applying to only one particular branch. At the same time, there is much to be done in enlisting the sympathies of large employers of foundry labour, and instituting a system of encouraging youths to carry on their own education after the ordinary school years.

We look with interest and hope to the efforts which are being initiated by the British Foundrymen's Association. The work will necessarily be arduous at the commencement, but the results will be full justification and a benefit to the nation at large. Further, in view of the tendency towards educational reform which has been exhibited during recent years in many quarters, a strong movement in the foundry trade might fairly be expected to give a lead to other branches of industry which suffer similarly from lack of systematic training of the rising generation of workers.

Culture in the Education of Engineers.

Leaving for the moment the question of apprentices and their training, and turning to the question of education from a broad standpoint, we cannot do better than quote the following extracts from an address delivered by Mr. W. L. Saunders, whose name will be known to our readers as the head of the Ingersoll Rand Company. The writer gives what we consider to be one of the clearest expositions of the true objects of education which have come to our notice. The address was delivered a few weeks ago before a gathering of students:—

Education in its broadest sense is mental and moral training. Colleges differ from common schools in that they aim at higher planes of mental and moral life. The small boy is taught by stuffing, as one puts sawdust in a doll; this is because his mind has not grown to the stage when it can think for itself. Impressions are received and transfixed by memory; the process is one of mental photography; the moral code is learned by rote as though it were the multiplication table. Not so with the older, the college student; his highest aim in education is to learn to think for himself. "If you are a student, force yourself to think independently; if a teacher, compel your youths to express their own minds," writes Dr. Osborn; and again, "The lesson of Huxley's life and the result of my own experience is that productive thinking is the chief *means* as well as the chief *end* of education."

Now what is productive thinking? Let me answer this question by giving you Huxley's definition of culture:—"The pursuit of any art or science with the view of its improvement." The storage process

is of paramount importance only when applied to elementary education. It is but the auxiliary of the scholar who has passed from the junior to the senior stage of student life, and who aims to do things in the world. The pursuit of facts is a mathematical study. It is important that we should know them; but even a large volume of facts when stored in the human mind is powerless to add one cubit to progress. Knowledge is power, but reason is power in action.

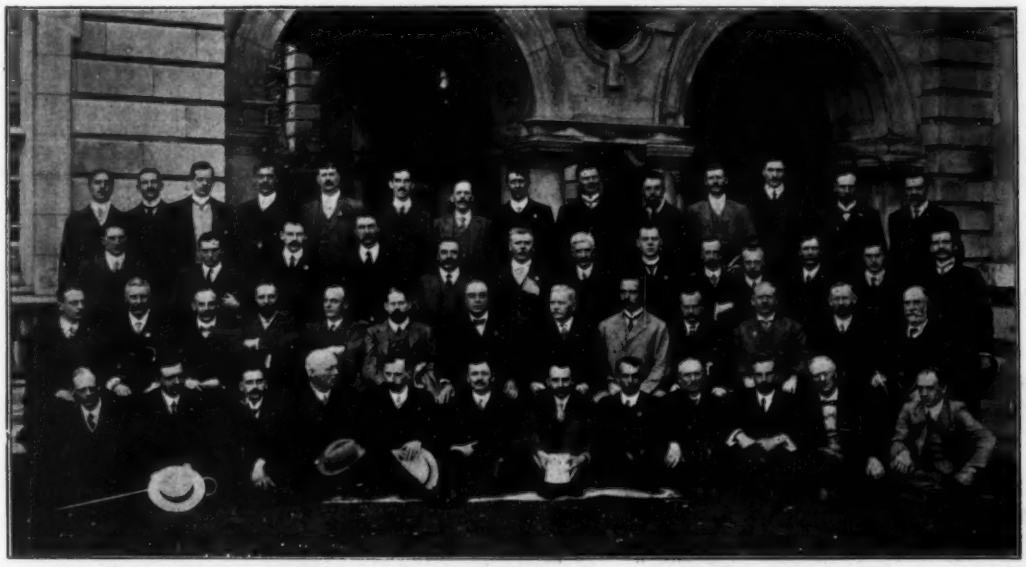
Where among all the professions do we get the results that come through productive thinking as from engineering? The engineer is the architect of the world's progress. Transportation in railways and ships, in motor cars and aeroplanes, is the productive thinking of mechanical engineers woven into our industrial life. The men who did these things were students of science, not that they might be mere storehouses of knowledge, but that they might produce. Civil, electrical, chemical and mining engineers are fields which afford infinite opportunities for research and progress.

Even Huxley feared that men might be over-fed scientifically when he said: "An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that a scientific college would turn out none but lop-sided men."

All this bears upon culture in its broadest sense. Productive thinking is the most important form of culture. It makes for power, refinement, progress, knowledge, taste, civilisation. A graduate of the higher institutions of learning misses his opportunities and discredits his college if he does not carry throughout all his walks of life the imprint of the educated man. *Noblesse oblige* is a degree and an obligation which is uniformly conferred upon all college men. To carry this obligation properly one should study culture in all its phases and in its broadest sense. Study it as an undergraduate, and study it still harder and more fully through all your post-graduate life. To this end let us accept and profit by that definition of culture given us by Matthew Arnold: "Acquainting ourselves with the best that has been known and said in the world." A professor defined culture as that which is left after all else learned at college is forgotten.

Good speech is a rule of manners. It always avoids exaggeration. Moderation in language and tone is the trademark of good breeding, and good breeding is after all mainly a matter of self-culture. The man of education mixes with the right kind of people and reads good books. Books lead us into pleasant paths of culture and happiness. Read that you may avoid worry; read that too much hard thinking may not dull the edge of intelligence and sap the roots of memory; read that you may know what has been done in the world; read that you may acquire that power which comes from knowledge; read that you may learn to value the example of great men's lives; that through them you may know that the grave is not the goal of life.

But of greater importance than good speech and reading, of higher value to the engineer than manners, is ability to write good English. Engineers are not given to public speaking; they pride themselves in being workers. It is very true that the engineering profession is one of practical work; but no one can hope to achieve prominence in this profession who cannot write good understandable English. An engineer may not talk, but he must make reports; he must write letters; he should draw specifications and plans. To do these things properly he must command and know how to use the tools of language. Lord Bacon tells us that "reading makes a full man, conversation a ready man and writing an exact man." Engineering is an exact science; accuracy is the one column on which the whole structure is reared. To write clearly and accurately can hardly be called an accomplishment; it is really a necessity.



MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION ATTENDING THE ANNUAL CONVENTION, HELD AT CARDIFF.

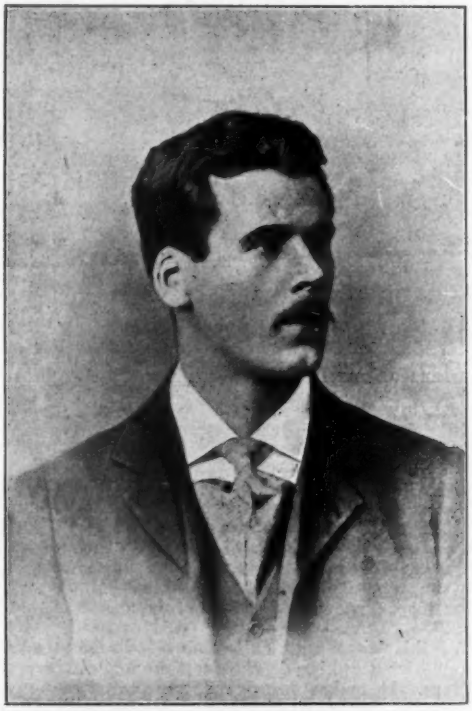
British Foundrymen's Association.

Ninth Annual Convention at Cardiff.

The Ninth Annual Convention of the British Foundrymen's Association was held at Cardiff, in the University College of South Wales and Monmouthshire, on August 6, 7, and 8. The very substantial growth of the Association during the year, largely through the addition of two new branches (Halifax and Newcastle-on-Tyne) was in itself sufficient to ensure a large attendance, but the concurrence of the meeting with members' holidays was responsible for many absences, especially of Scottish members. There was a substantial representation from the Principality, partly accounted for by the popularity of the new President, Mr. Charles Jones. A very important step was taken at this gathering, in the decision to select a date in May for future Conventions, at the discretion of the Council. The Convention, on the whole, was most successful, although, in the matter of weather the gathering was singularly unfortunate, some of the visits having to be made in a heavy downpour of rain. The South Wales centre has many points of interest for visitors from other parts of the Kingdom, and the citizens are justly proud of their remarkably fine group of municipal buildings, comparing favourably with those of any other provincial city. The great activity at the docks and the general bustle showed that South Wales is fully sharing the general wave of prosperity.

CHARLES JONES, PRESIDENT OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

At the opening proceedings, on Tuesday, the retiring President, Mr. Percy Longmuir, B.Met., occupied the chair, and there were also present the ex-Presidents, whose portraits occupied a conspicuous place in a handsome and well-bound souvenir volume, in the form of a "Guide to Cardiff," presented to the members. There were also present the following:—Birmingham: H. Winterton, J. B. Tattersall, P. Fox-Allin, J. G. Dobson and J. Horton; Brighouse: F. Gledhill; Bristol: M. H. Curnow; Blaenavon: W. Jones; Bury: H. Grandridge; Cardiff: H.Griffiths, A. Hamilton, W. H. Gould, W. Williams, G. Blackmore and R. G. Smith; Castleton: A. Harrison; Chesterfield: S. G. Smith; Dereham: H. Jewson; Dursley: F. J. Cree; Falkirk: M. Riddell; Glasgow: Professor A. Campion; Horsehay: T. Macfarlane; Halifax: W. E. Noon; Kent: D. G. Mather and G. M. Mather; Leeds: T. B. Holt; London: J. C. Miller, R. Woods, J. W. Horne, J. Oswald, W. A. Young, and H. S. Green; Luton: J. Ellis; Loughborough: J. Herfoot; Lincoln: T. Feasey; Manchester: W. Smalley, H. Aspinall and F. Penlington; Newark: V. L. Cannell; Oldham: H. P. Mason; Pontypridd: B. E. Lewis; Portsmouth: B. Sperring; Paris: P. Delalande; Stroud: J. Bennett; Sheffield: J. B. Durrans and W. F. Bagnall; Shropshire: W. Harrison; Southampton: G. B. Henderson; West Bromwich: D. Dalrymple; Weymouth: A. E. Dowding; Walsall: W. J. Foster; Wednesbury: G. B. Richards. A number of lady friends were also visiting Cardiff, and special arrangements for their entertainment were made during the progress of the meeting.



PERCY LONGMUIR, B.MET., RETIRING PRESIDENT OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

The CHAIRMAN, on behalf of the Council of the parent Association, offered a very hearty welcome to the members, remarking that they anticipated a very

good time in Cardiff, and some had already commenced that experience. Letters of apology were read from Messrs. Mayer (Dumbarton), C. Heggie (Birmingham), W. H. Sherburn (Warrington), W. Kenyon (Accrington), and R. Mason (Australia). A letter of introduction was also presented from the Association Technique de Fonderie, whose headquarters are at Charleville, France, introducing Mr. P. Delalande as their delegate.

Election of Officers.

The meeting next proceeded to the election of officers. The Chairman proposed for the position of President of the Association for the next session, their old friend, Mr. Charles Jones, of Cardiff. No man was better known in the city, and for a long time also the heads of the Association had had the pleasure of his acquaintance. They considered him most worthy to fill the chair. They were all so familiar with his good points, that there was no necessity to reiterate them. Above all, he was a man of industry and a man of sound business, and also possessed a fund of humour that would be immensely useful in the chair.

Mr. F. J. Cook, in seconding the election, said he had the greatest pleasure in supporting everything that had been said by Mr. Longmuir. As an Association, they had always had in the forefront of their objects the promotion of education, and he did not know any man in the foundry world who had done more to inculcate among the young people of his own works the desire for knowledge than had Mr. Jones. His influence throughout the district, in the same direction, had been very valuable. Among other things, he had offered prizes to his own apprentices, and had assisted the Association by inviting speakers to address the young foundrymen. As a growing institution they needed a sound business man at the head, who possessed plenty of business acumen, and the best possible recommendation in regard to that was that Mr. Jones had built up and maintained a very successful business of his own. The Association also sought to inculcate the idea that it was their duty to help along the practical man, and in that respect Mr. Jones had many qualifications. He had gone right through the works from the floor onwards.

The vote was carried with acclamation.

Mr. C. Jones, in acknowledging his election, said he was exceedingly obliged and highly gratified to find that they had such confidence in him as to place him in the chair just vacated by Mr. Longmuir. It was no easy task to follow the retiring President and the other brilliant men who had occupied the chair. With their sympathy, confidence and support, however, he would do all in his power to promote the welfare of the Association and to assist in carrying on its good work.

Mr. Longmuir said he could assure Mr. Jones, on behalf of the whole of the members, as well as of the Council, that he would have their heartiest support, and they had every confidence that he would be a great success in that position. (Applause.)

The President (Mr. Jones) proposed Mr. Sidney A. Gimson as senior Vice-President, and Mr. Buchanan, supporting this, said that Mr. Gimson had taken a very active interest in the affairs of the Association, while he was closely connected with ironfounding and engineering, and had had a large amount of experience in public affairs. He was certain that when the time came for him to occupy the chair, he would prove a source of strength to the Association.

Mr. Gimson was elected, and briefly acknowledged the vote.

Mr. H. Pilkington proposed the name of Mr. Mayer, of Dumbarton, as junior Vice-President, remarking that, as they were aware, the election to that office was really a preliminary selection for the Presidential chair. Mr. Mayer was very popular with the Scottish Branch, and that, in itself, was sufficient guarantee for the support of the Association. He was a practical ironfounder and a man of experience. He had already done excellent work in Scotland, occupying much the same position there as Mr. Jones did in South Wales..

The proposition was seconded by Mr. J. Oswald (London) and carried.

On the proposition of Mr. G. B. Henderson (Southampton), seconded by Mr. S. A. Gimson (Leicester), Mr. F. W. Finch was re-elected Treasurer, the latter speaker remarking that as long as the Association existed, and the earlier promoters remained members, they would wish to have the name of Mr. Finch attached to it. He did so much in starting the Association that they desired to still have him associated prominently with them.

Mr. Longmuir proposed the re-election of Mr. Allbut as Secretary. The Association was growing very rapidly and that meant that a large portion of the work (and practically the whole of the work resulting from that extension) fell upon the shoulders of the Secretary. The report showed that the membership was now nearly 900, but that did not convey a proper impression of the large amount of secretarial work, of the heavy correspondence involved, and the time taken in the discharge of those duties. They had a high regard for the present Secretary, and he believed that was the third time he (Mr. Longmuir) had proposed his election. At the same time, he proposed that a small grant, not in any sense a salary, for the coming year, be made of forty guineas, in recognition of his services. (Applause.)

Mr. J. W. Horne (London), in seconding the vote, said he knew the interest that Mr. Allbut took in the development of the Association, and when the London Branch was formed he was present, at some pains to himself, at the inauguration. They never looked in vain for his assistance.

The vote was carried with acclamation, and Mr. Allbut, in acknowledging, said it was true the work was increasing very rapidly, and he was afraid he would not be able to retain the office very long, but for the present he would do his best in the position for the benefit of the Association.

At a later point in the proceedings the Secretary read the result of the ballot for the election of members of the Council, the following having been chosen:—T. Macfarlane (Messrs. The Horsehay Company, Limited, Shropshire), T. H. Firth (Messrs. The Brightside Foundry and Engineering Company, Limited, Sheffield), G. B. Henderson (Messrs. J. I. Thornycroft & Company, Limited, Southampton), W. H. Hatfield (Messrs. Crowley & Company, Meadow Hall Ironworks, Sheffield), J. Oswald, M.I.Mech.E. (Sleaford Foundry, Nine Elms Lane, London), T. Smith (South Shields).

On the proposition of Mr. V. L. Cannell (Newark), seconded by Mr. G. M. Mather (Kent), the report and balance-sheet were approved and adopted.

A hearty vote of thanks was accorded, on the proposition of Mr. H. Winterton (Birmingham), seconded by Mr. T. Feasey (Lincoln), to the officers for their services during the year, Mr. Winterton remarked that the report showed how well and successfully the officers had carried on the business of the Society.

Alteration in Date of Convention.

Mr. R. Buchanan, introducing a resolution dealing with the dates of future conferences, said that it had appeared for a considerable time past very desirable that the date of the annual meeting should be altered. One reason was that they had pretty well exhausted the various places where work was carried on during August Bank Holiday week. He had very little doubt that in the minds of the members, as a whole, the

visits to works played quite as important a part in inducing members to come to the Convention as did the reading of the Papers. His real intention was to ascertain the opinion of the members as to the advisability of holding the meeting during August Bank Holiday week, or changing the date and leaving the

SIDNEY A. GIMSON, SENIOR VICE-PRESIDENT OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

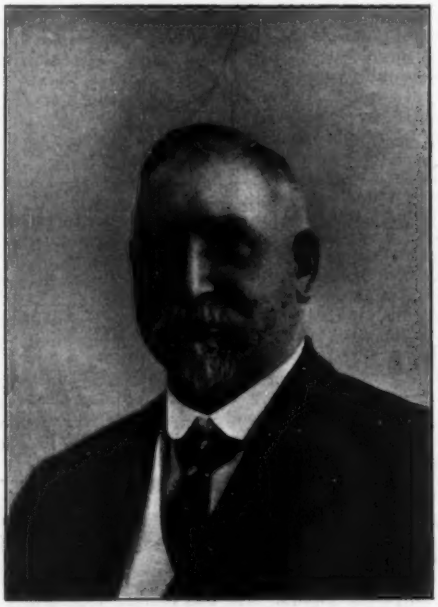
Council to choose a suitable one, in the event of their considering that a change was advisable. Their sole desire was to get the most suitable date. He would move "That this meeting give the Council leave to alter the date of the annual meeting, if they deem it advisable."

MR. H. PILKINGTON seconded the motion, and after some discussion, in which MR. P. LONGMUIR, F. J. COOK and others supported, the resolution was modified so as to merely alter the date of meeting to the month of May, leaving the Council to fix the date. The resolution was then carried unanimously.

The PRESIDENT said it gave him very great pleasure to introduce to the meeting Principal Griffiths, the head of the Cardiff University, who had promised to attend and address the meeting.

Address by Principal Griffiths.

PRINCIPAL GRIFFITHS said he was glad to have the opportunity of saying a word or two about matters which might be of concern to members of the Association. He hoped he might regard their meeting in that College as of some significance. In other words, it showed their belief that practical applications of science should, to some extent, go hand in hand with theoretical work in pure science. That was a fact which he thought wanted bringing home to a very great extent, not only to members of the different professions, but to the public also. That fact had been grasped in Germany to a much greater extent than in this country and it was also being grasped in the United States. He was not going too far in saying, as he believed they would all agree, that the prosperity of this country depended on its industries, and those industries depended on the application of pure science. It was not for him to talk to them about their own business; but, taking a broad view, all kinds of industry, including ironfounding, were based on the applications of pure science. Let them think for a moment what the condition of the industry of the country would be if they blotted out the names of certain great scientific men. Let them take one striking example only, namely the application of electricity. In this country there were about two million people depending on electrical manufactures, and really those two million people were living on the brains of Faraday. It was Faraday who found that the production of electricity by mechanical means was a possible thing, and all the subsequent development was really founded on that man's work. They might answer that if he had not made the discovery probably somebody else would. That was very likely, but the discoveries might have been made two or three generations later. He wanted very much to bring home to those engaged in practical work that the influence of pure science and research was very great on practical work, and that its encouragement was very far from having merely a remote bearing on practical questions. Reverting to Faraday, one of his most memorable works, which occupied him for several years, was the construction of a very primitive and inadequate machine by which, with the expenditure of mechanical labour, it was possible to obtain a flow of electricity. At the close of one of his lectures at the Royal Institution this machine was shown, and afterwards a lady came round and said, "Well, but, Professor Faraday, what is the use of it?" He replied, "Madam, can you tell me the use of a new-born child?" That was one of the greatest answers ever given, and exactly put the case for scientific discovery. It might be quite true that the practical use of a discovery might



W. MAYER, JUNIOR VICE-PRESIDENT OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

not immediately appear, and that application might have to wait for a generation, but there was no fact added to their knowledge of pure science which was not, in the course of time, utilised for the benefit of mankind. Only think what that new-born babe of Faraday's had become, and they might form a judg-

ment of the vast use which might yet be made of other discoveries in pure science.

The speaker, proceeding, referred to the work of Sir William Crook, Hertz, and others, and the service their researches had rendered to the country.

Acknowledgem nt to Principal Griffiths.

The PRESIDENT said they could not let that opportunity go by without thanking Principal Griffiths very sincerely for the very able address he had given to them.

MR. PERCY LONGMUIR, in seconding, said that the remarks of Principal Griffiths would give them food for considerable thought and reflection during the coming winter. The reference to the early development of wireless telegraphy, particularly to such a remote thing as the work of Hertz, was extremely suggestive, and was, no doubt, a useful lesson to those who were rather too anxious to get "quick returns."

Presidential Address.

The PRESIDENT proceeded to deliver his Presidential Address as follows :—

Permit me, gentlemen, to convey to you again my earnest appreciation of the honour you have conferred upon me by electing me as your President for the coming year. It is an honour, I can assure you which I will do my utmost to deserve, and though it is with a considerable amount of diffidence that I have accepted the position so worthily held by brilliant members of our Association, yet I am conscious that your confidence and support will be of great assistance and encouragement to me in carrying out the responsible duties attached to the office.

With the rapid growth of our Association, the responsibilities of its officers have naturally increased, and when it is recalled that on the occasion of our first Convention in 1904, eight years ago, at Manchester, our membership was only 83, it will be at once acknowledged that the progress of the Association during the intervening years has been little short of phenomenal. We number to-day 910 members, and this fact alone is sufficient evidence that the work and objects of our Association appeal to, and are appreciated by, the members of our trade, and that our existence as an educational body has been amply justified.

These annual gatherings are the milestones of our progress, and held as they have been in the industrial centres of Great Britain "midst factories, smoke and ceaseless din," have tended to make us feel that, as members of the British Foundrymen's Association we have some relationship with the working life of those cities, whose engineering shops and foundries seem to us to be part and parcel of our daily existence.

It is, therefore, quite appropriate that the City of Cardiff, whose name is never mentioned without the mind naturally flying to the export trade with which it is so intimately connected, should be honoured with a visit from our Association. Coal, as was so conclusively proved in the industrial trouble earlier in the year, is indeed to us as foundrymen our staff of life, and while we in Cardiff cannot boast, like Glasgow, of shipyards in which are built incomparable vessels, sailing ships and record-breaking liners, swift destroyers and death-dealing Dreadnoughts, or like Sheffield and Birmingham, of their immense production of world-famed steel and other metal ware, we can show you appliances for winning the coal from the bowels of the earth, and apparatus for despatching with record-breaking haste, the "black diamonds" to the uttermost quarters of the globe. But the immense improvements of comparatively recent years in mining, engineering, and in our modern coal-tipping appliances, no less than in almost every other mechanical industry in our country, have not been obtained all at once. It has been, naturally, a gradual evolution, assisted to a great extent by the sound scientific and technical education obtained at our universities and technical schools; for it is not only in the workshops to-day that men get the training and knowledge which enable them, by adopting modern ideas and modern systems, to keep abreast of the times.

We, as foundrymen, are, of course, proud of the antiquity of our craft; but ancient methods must give way to modern requirements, and as each progressive step takes place in the advancement of our work, we must, as employers and managers, fall into line, or get left behind in the forward march of the present day.

Now it appears to me there is much to be done, and much that the British Foundrymen's Association can do, in this matter of education. We must admit that all the theoretical knowledge in the world cannot make a practical moulder, but to the practical workman the theoretical knowledge to be obtained at technical schools and colleges is simply invaluable. There are, no doubt, many present who, like myself, deeply regret that in their youth the opportunities did not exist for the acquirement of that sound scientific, technical, and commercial knowledge which to-day is so readily placed within the reach of all; and with a full recognition of the immense benefits to be gained, it should be our duty not only to encourage and assist apprentices to attend technical classes generally, but to take the necessary steps to obtain the inclusion in the syllabuses of our technical schools of a class in foundry work. There are, indeed, few industrial centres in Great Britain without evening technical schools—many of them with a wide range of subjects—and I am certain that if our Association used its weight and influence with the educational authorities in the respective centres, our representations for the inclusion of a class in foundry work would not go unheeded.

But even after an educational authority has agreed to the teaching of a certain subject, there is oft-times a difficulty about the formation of a class. Technical schools generally insist on the enrolment of a minimum member of students—that minimum ranging from 10 to 20—and it occasionally happens that a subject is cancelled, owing to the failure of a sufficiency of students to make up the requisite number. This is where the influence of the individual employer and manager may be useful in encouraging the lads to attend the class, even to the extent, if necessary, of paying the fees. By showing personal interest, a great deal can be done towards stimulating a lad's enthusiasm for his work, and a few words of encouragement and advice to an apprentice may be all that is necessary to persuade him to attend the class.

And may I here put in a plea to technical teachers, for simplicity of language. Even with our system of compulsory elementary education, the majority of our boys are not trained to understand severely technical terms and scientific formulæ, and I, unfortunately, know instances in this city where certain classes have been failures, simply owing to the inability of students to digest the instruction given. It is, therefore, very necessary indeed, in order to make a technical class a success, that the student may be *interested* as well as instructed, and I can imagine no better method of doing so than by the regular institution of a practical night in connection with the class. We cannot expect every educational authority to lay down a foundry plant (although some colleges like Glasgow, Liverpool, Sheffield, and Birmingham are particularly fortunate in this respect), but surely we could depend on employers giving some practical assistance by placing a por-

tion of their foundries at the disposal of the teacher. There are so many little things that may be shown and taught in the familiar surroundings of the workshop, so many questions that can be asked and answered, that nothing but good can fail to come from such a form of instruction.

J. E. H. Allbut, General Secretary of the British Foundrymen's Association.

Encouragement can also be given by employers and managers in offering local prizes; and in the case of well-educated and ambitious apprentices, I would advocate the attendance at classes, in other subjects kindred to the trade, and I earnestly support the suggestion of our Council with regard to the establishment of national scholarships for the most proficient students in foundry work and the allied subjects. Such scholarships would not only be an inducement to lads to use their education as a stepping stone to better their position from that of an ordinary moulder, but in my humble opinion would eventually do good work in raising the status of our workmen. As you all know, by increasing the intelligence and knowledge of the apprentice in regard to his work, we should be sowing seed which would be fruitful to us in the future. The apprentice of to-day is the workman of to-morrow, and I cannot hold with the system of using lads purely as money-making machines by keeping them at routine work, which, however remunerative to the employer for the time being, must mean a poor prospect for the lads; and not only that, but it means the breeding of inefficient workmen, with consequent loss to their future employers.

We all know, as practical men, that notwithstanding the time, trouble, skill and care spent in making an intricate mould, jobs sometimes go crooked, and turn out wasters; but speaking generally, the wasters, in the majority of cases, can be traced to the employment of inefficient workmen. I really know nothing more saddening than the man—of any trade—who has not been thoroughly taught during his apprenticeship; and who, after he has become a journeyman, has practically to learn his trade over again: and though his inability is soon found out, with the consequent loss of his job, it is his successive employers who suffer financially from his inexperience.

It is true that by his failure the wise man learns, but let us do what we can to minimise those failures by promoting the cause of education amongst our lads, and let us supplement the theoretical knowledge the young apprentice will acquire at his school, with every encouragement we can give him in his practical work.

In my own opinion, the suitability of the jobbing shop as a training ground is greater than that of the large concern, where the work of one day is largely a repetition of that of the day before. But the necessity for skilled and careful workmen is the same, and, unfortunately, in many workshops the apprentice does not get the advice and assistance from the skilled workman to which he is fairly entitled. The old hand, with his years of experience oft-times gained at his employer's expense, does not impart his acquired knowledge very readily. He has always before him the day when he will be replaced by a younger and possibly more capable workman, and he hoards his knowledge with what is after all a perfectly natural selfishness. In these days, however, of socialistic tendencies, it is gradually being recognised that the State has a clear and imperative duty towards the aged and infirm workman, and if this principle be ultimately realised (as even now seems more than probable) then it will become the duty of the workman to the State to impart, to the best of his ability, the skill and knowledge which his long experience has given him.

But apart from the matter of State duty, let us encourage our foremen and journeymen to help the apprentices, and to this end let the British Foundrymen's Association, as a purely educative body, do all

F. W. Finch, Treasurer of the British Foundrymen's Association.

in its power to extend its membership. As I have already mentioned, the increase in our numbers since our first meeting in Manchester has been phenomenal, and there is really no reason why the present membership should not be considerably augmented. There is no better means of propaganda than the personal

one, and if every present member would only consider it his duty, in season and out of season, to advocate the claims of our Association amongst those members of our trade with whom he comes in daily contact, I have not the slightest doubt that, in a very short period indeed, the numbers of our Association would swell to such an extent as to be a great force in the foundry work of this country.

I am convinced also that if the various employers could only be got to recognise the advantage of membership to their workmen, and consequently to themselves, there would be little difficulty in obtaining from them that encouragement and support—moral and financial—which we ought to have in a much greater degree than we have at present. Our ranks are open to all connected with our craft, and our scheme of Members and Associates, with our system of a graduated subscription scale, brings membership within the reach of every intelligent workman and apprentice. No matter how high one may stand in his trade or profession, one can always learn from the workman; and the workman with brains and ability is what every employer is looking for. Better jobs await such men, and by becoming members of our Association, latent talent will have an opportunity of revealing itself, not only in the reading of papers at our conferences, but in obtaining practical assistance in conducting any investigations they may care to make in the hidden mysteries of our ancient craft.

The educational advantages of belonging to local Branches of the Association must not be overlooked, and I hope that my year of office will see the establishment of one or two additional Branches in our industrial centres—Branches which I fondly hope will be the means of obtaining for their members that proportion of technical education to which the foundry industry (no less than that of the engineering and other trades) is clearly entitled.

Gentlemen, the welfare of our Association, with which, in my humble opinion, the cause of education is so intimately linked, is very dear to us all, and I should like, in conclusion, to express the hope that every member of the British Foundrymen's Association may consider it his duty, as well as his pleasure, never to miss an opportunity of furthering and extending its tenets, and I am convinced that the clearer understanding between employer and employé which must assuredly result through the medium of our Association will greatly tend to decrease these causes of friction which so often lead to results eventually deplored by all. "'Tis a consummation devoutly to be wished." (Applause.)

Discussion on "The Training of Apprentices."

The Convention then proceeded to the reading and discussion of Papers, the first taken being the one by Mr. J. W. Horne, B.Sc. (Edin.), A.I.C.E., on "The Training of Apprentices."

This Paper is given in full on Page 555.

Mr. Horne prefaced his Paper with some general observations. Referring to the address given by Principal Griffiths, he said no one was more delighted than himself to hear the Principal's plea for higher education and for the practical application of pure science. It had been a still greater delight to hear the remarks of the President on the relationship which should exist between the apprentice and the master. The two addresses were a very suitable introduction to his own Paper, outlining what was being done in various countries to train foundrymen. He was especially pleased to hear that the Council had voted a sum of money for the establishment of a foundry scholarship. He considered that the dual system of training in the workshop and the college was quite a possibility, provided the discipline was equally strict in both, and he thought that it would produce the right type of foundryman. In Germany the period of apprenticeship was four years, in America five years, whereas in Great Britain the period was seven years. He was especially disheartened at the difficulty of inducing the foundry apprentices to read foundry text-books and publications. He was very glad to hear that there was a representative of the French Foundrymen's Association present, because he had not been able to get any very definite information as to whether the French foundries were doing anything to improve the standard of the young foundryman, and he should be very glad to hear any information on that point.

Mr. R. H. Greaves (Cardiff) said the subject before them was very important. The Paper presented information of what was being done elsewhere on lines practically untouched in England, and it was to be hoped that the suggestion made at the end of the Paper would bear fruit. He noticed, particularly, that in no case was theoretical training made an additional burden on an already hard-worked lad. Many people had spoken as if compulsory attendance at a technical school or continuation school would solve the difficulty. But the young apprentice was just beginning to feel his independence, and much more good could be done by appealing to his interests than by forcing him back to his school desk. He thought they might assume that they all had two interests, They had an interest in their work, and a social interest. If both those interests were properly trained something might be made of them. A course of instruction directly connected with the practical side of foundry work would immediately appeal to the interest a man had in his work. Personally, he should not include in such a course, as subjects of instruction, courtesy, citizenship, order and peace, and other things which might have a strange appearance to British eyes. But Germans had been brought up on that sort of thing from their infancy in the elementary schools. Possibly, there might be a difference of opinion as to the wisdom of including those subjects in a course of instruction. In any scheme he thought three points must be remembered. First, no compulsion must be employed at the expense of reasonable leisure; secondly, that technical school training was useless if it was isolated from practical work; and thirdly, that the social instincts should be trained and fresh interests awakened so as to produce good fellowship and good citizenship. (Applause.)

Mr. R. Buchanan (Birmingham) said he thought the foundry trade, as much as any industry, could congratulate itself that even so late as the year 1912 the apprenticeship system was in fairly strong force, certainly throughout the engineering and jobbing foundries of the country. That was a fact which he considered of the utmost importance when they were looking for fresh developments of the British foundry trade. They must, of course, agree with Mr. Horne that the foundry unfortunately had attracted the less intelligent lads as a rule, and he was afraid that the conditions of the work in the foundry were such as to be less attractive to those who were better educated. He felt bound to differ from some of the speakers with regard to continuation classes, he feared that they were not likely to secure attendance at evening classes, except under compulsion. He thought it was very necessary to protect the lad from 14 to 16 years of age against himself, and the companionship which he so readily acquired during those impressionable years. Those compulsory powers were enforced in Scotland at the present time, and he had heard no particular outcry about the hardship of having to go to those evening classes. There would, of course, be differences of

opinion on the question, but he had expressed his personal predilection for compulsion. Hugh Miller remarked in one of his books that a lad might neglect his school life, and suffer no particular harm, provided he made the best of his second schooling, which consisted of his apprenticeship, and the use of his

H. L. Reason, President of the Birmingham Branch of the British Foundrymen's Association.

leisure time in his youth. But there was plenty of evidence that many of the apprentices in the foundries were neglecting also the work of their second school, and if a lad neglected his second school, which was his apprenticeship, that was absolutely disastrous. There was no possibility of amending the neglect of apprenticeship. He (the speaker) was quite in agreement with any steps that might be taken, even compulsory steps, that would amend the situation so far as to improve the material coming into the foundries. He agreed fully with what the President had said, and also what Mr. Horne had said as to the duty of the employer to interest himself in his apprentices. He was afraid that in many works, especially where repetition work obtained, there was a sad neglect in the training of the lads, and the future was not encouraging. But he hoped that the Association might do something to improve the situation.

Mr. S. A. Gimson (Leicester) said there were one or two points in the Paper on which he was not altogether clear; perhaps Mr. Horne would put him right. The author mentioned three conditions to be satisfied in securing a proper apprenticeship, the first of these conditions being: "Adequate supervision for boys up to 18 years; supervision must take into account conduct and physical development." It did not seem to him (the speaker) that general conduct and physical development should be taken into account in an apprenticeship. The object of an apprenticeship should be to teach a particular business, and the supervision of the boys as to their moral and physical development, should come mainly from the home. At the same time, it was quite right that an employer should take an interest in the boys under him. But surely the moral and physical welfare of the children should be attended to by the parents. Coming next to the propcsition that a youth should have alternate training by means of a week in the shop and a week in the school, a practical difficulty would seem to arise. There would either be only half the number of apprentices required in the foundry, or twice the number going through training; and in the latter case they might be going far beyond the demands of the trade. It was clear they were on the horns of a dilemma. If they were to go on training a large number of apprentices they would need to largely extend their trade, and if that large increase in the number of workmen went on where trade was not expanding, that must lead to difficulties, and it seemed also that that difficulty would be emphasised in this country if the German system were followed, because Germany had a five years' apprenticeship, according to Mr. Horne's Paper, whereas in this country the period was seven years.

Mr. H. Pilkington (Chesterfield) said the foundry's greatest difficulty was with regard to the raw material as it reached the foundry. Too much of the literary idea existed in high quarters, and a great many of His Majesty's Inspectors of Schools were simply imbued with ideas from Oxford, and commercially they had not the slightest notion of training boys for what they were about to earn their living by. The result was that when the boys went on to secondary or science class education they were not in a position to acquire in the secondary schools and in the continuation schools what was put before them. He considered that the primary education would have to be altered to be made less literary and more general, and more in the direction of fitting boys to acquire science training afterwards. Something had been said about boys

George Hailstone, Secretary of the Birmingham Branch of the British Foundrymen's Association.

objecting to go into the foundry. He found that the boys living round the works in his district would go down the coal pit with very great willingness. That must be a still more unpleasant occupation, yet they preferred to go down the coal pits rather than to go into the foundry. In regard to the training at the

works, they started the boys at 14, and that applied both to the foundries and the engineering shop. They had a system with the best boys by which they allowed them to go to an educational institution, whether in the afternoon or otherwise. But, anyway, they let them off to attend either the science school or the University. Some of them went to the University at Sheffield, or to science schools in the neighbourhood, and they were allowed to leave early on their class nights. In addition to that, they had certain members of their own staff who carried on classes as well, and those had been much more successful than anything else. Boys were passing through from the drawing office to the works and from the works to the drawing office, but they had to show good work in their classes and assiduity in attendance and a general willingness to improve themselves, if they wished to do this or to go to the other parts of the works during their apprenticeship. He only wished that there were some eagerness amongst the boys in the foundries to go through that system, which there was not. He thought perhaps they were tending back again to the old kind of apprenticeship, which they must admit had for many years been badly neglected, and he feared that in the large limited companies the personal interest which a manager was able to take in his boys was much less close than formerly, and managers and proprietors would have to display a good deal more social interest in their youths than they had shown in the past. They might very well interest themselves in the games and recreations of the youths, as well as in their work in the foundry, and that general interest would probably help to encourage the youths to go in more for the scientific part of the training. (Applause.)

Mr. S. G. Smith (Chesterfield) said he was rather struck with the remark that Mr. Horne made on the first page, to the effect that as soon as an apprentice had completed his term of apprenticeship he was advised to go into shops for experience. Really, that was the richest experience that a young man could get, and there was no better experience than for a young man to go from one place to another, and it would pay him even if he went to places hundreds of miles apart. That was his own experience, and he had never regretted being in any of the shops. The knowledge he had picked up had always been useful. He wished to specially call attention to the paragraph in which the writer said: "The problem of the more efficient education of the engineering mechanic has during late years had the serious consideration of many industrial firms, with the result that considerable progress has been made. But, so far as information can be obtained, no great development has taken place in improving the educational standard attained by the foundry apprentice, though the problem has not been neglected by foundry employers. Perhaps the main reason why development in their case is and has been so slow is associated with the fact that as a trade moulding is generally held in low estimation." Why foundry work should in any sense be held in low estimation had always been a mystery to him, but he appreciated every word of that sentence. He knew that in some quarters they were looked down upon as being a lower grade of mechanic. (Laughter.) No trade demanded so much intelligence, patience, faith and pluck, and he could not for a moment think why the position of the moulder should be held in low estimation. Passing on to the educational part, Mr. Horne had tackled a difficult problem. He considered, after all, that the best influence that could be brought to bear upon a young man was advice from his foreman; if the latter could get social intercourse with him an influence might be exerted to persuade him to educate himself, and take advantage of the many classes and opportunities now offered. His (the speaker's) hope was still in the continuation classes which were carried on in some parts of England. He knew two or three places where practical moulding classes were carried on in the evening, and those classes had been very successful. They could not spare the lads to go to afternoon classes, as had been suggested. In connection with the Ludwig Loewe & Company system described, the period of four years seemed to be nicely divided, and should give a young fellow a fairly good start, although a moulder would know very little at the end of the four years. Personally, he knew very little when he had been at it 25 years, and he did not know much now. (Laughter.) When he commenced he was an indentured apprentice, a thing never heard of now. But that apprenticeship was not carried out in a proper spirit, because he was used to a certain extent as a money-making machine only, and he feared that that spirit existed now.

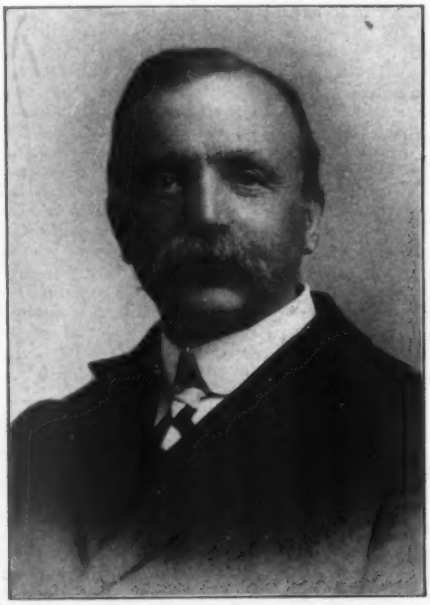
Mr. F. J. Cook (Birmingham) said that the subject was a very wide one, but one thing which was apparent to everybody who had any direct contact with the foundry, was the low grade of boy who was attracted to it. Everybody was aware that there was not only a low grade of education, but that in large cities the boys were very often physically unfit for the work in a foundry. He agreed also that to entail a large amount of study upon a boy after a hard day's work was not a thing to be commended. He had a very great amount of sympathy with a boy who had worked in a foundry from six o'clock in the morning until six o'clock at night, very often at hard, laborious work, and would be one of the last to impose upon him compulsory attendance at evening classes. He was inclined very much to agree with Mr. Pilkington's remarks, because it was clear that very often their education was lacking through the failure of their study at the day school. The suggestion he had for improving that was somewhat anticipated by his own firm. That firm was very largely interested in the education of their apprentices, and had been very much concerned for many years with the very poor quality of boys they were able to attract to the foundry, and they were willing to help to such an extent as to give a larger rate of wages in the foundry than in any other department of the works. Further, they encouraged the scholars by means of scholarships, which first of all carried them to the day technical school and then to Birmingham University for a period of three years. During that time they were paid their wages just as if they were at work. Unfortunately, up to the present they had not been able to get a boy in the foundry who had been able to work up to that degree, but he was pleased to say that there was a distinct leaning towards their desire for knowledge on the part of the average foundryman. In connection with their works he had been trying to help the young fellows by the foreman carrying on classes two nights a week at his own home, and during the two years the classes had been in progress they had been most successful. They had attracted young fellows from 18 to 30 years of age, and the interest shown by those young fellows was most encouraging. He thought the time had arrived for an Association such as theirs to take up that matter, and he would like to propose, therefore:—

> "That the Council consider this subject and form a sub-committee to deal with the matter and report to the Council as to the best means to be adopted to promote better education of young foundrymen."

It appeared to him that one of the things which could be done would be to get as much evidence as possible

of the systems adopted by large firms in this and other countries, and by studying the methods of apprenticeship, to try and evolve some rule which might be helpful to employers, and also a syllabus of teaching which might be properly adopted.

Mr. P. Delalande (Paris), responding to an invitation from the President to say a few words, said that



Ex-Bailey John King, Retiring President of Scottish Branch of British Foundrymen's Association.

he was glad to tell them that an Association had been founded in France to promote the interests of foundry trade, and it was becoming a very large technical association. He hoped after the close of the Convention to report their Proceedings to their friends in France, and he intended also, with the kind permission of the British foundrymen, to be able at a future meeting to tell them something about the work done in France. (Applause.) He thanked them very much for the reception they had given the French Association which he represented, and he had no doubt that his visit would prove the beginning of a warm and helpful companionship between the foundrymen of the two countries. He should be very glad on his return to France to tell his friends of the kind reception he had had in England, and he should also give them a Paper on the proceedings of the Convention, covering their Papers and the discussions, which he was sure would be extremely interesting to the Frenchmen. (Applause.)

Professor Campion (Glasgow) said that he must speak apparently as one of those unfortunate teachers referred to in the Presidential Address who had caused the failure of so many classes for foundry apprentices. Possibly he might be allowed a few words on the other side of the question. The President in his address made one appeal which he (the speaker) had tried to carry out. He had done his best to use simple language in his foundry class lectures. But that was not always a very easy thing to do, especially when dealing with technical subjects. Nevertheless, he had endeavoured to do it, and he had stopped to explain every expression which was apparently not very well understood. But that had its disadvantages, and in particular it compelled them in a session to deal with a very small portion of the syllabus. His class consisted not only of apprentices, but also of many others; those attending last year varied in age from 16 to 66, and nearly every year he had five or six men well over fifty. It was not compulsion that brought those men to the class. Mr. Buchanan had mentioned compulsion, but he (the speaker) did not believe it existed except in a few cases. Quite a number of foundry foremen recommended their apprentices to go to the class, but they did not compel them. When a man attended of his own free will, after having worked all day in the foundry, at a class which began at 8.30 p.m., and from which in some cases he would afterwards have to travel thirty or fifty miles, that was certainly a healthy sign. Yet some of them attended three nights a week; and they asked if there were not other classes they could go to, so keen were some of them. A good deal had been said about the hardship of attending a class in the evening, after a day's work. He quite agreed with that, and if the employers would co-operate, he was quite sure that in Glasgow, at any rate, they would be willing to establish an early morning class, such as they already had done in the engineering department, and he would suggest that it would be a much better plan if instead of apprentices attending in the evening they came, say, from eight o'clock to nine in the morning. The employers might excuse them coming until after breakfast, say until half-past nine. Students and lecturers would all be much fresher in the morning than at eight o'clock at night. They would be very glad to fall in with an arrangement of that sort. Under the Scotch system the college worked quite closely with the factory, and they had students passing not only from the shop to the College, but there were many works where the students were allowed to work some months to gain practical experience, and the Professors were readily granted permission to take the students to see processes in actual operation. That was a very great

Prof. A. Campion, F.C.S., Senior Vice-President of Scottish Branch of British Foundrymen's Association.

step in advance, and it secured co-ordination and co-operation between the scientific and commercial sides of metallurgical work. They could only teach the fundamental principles and induce the pupils to try and think for themselves.

With regard, continued the speaker, to the question of the supervision of the boys under 18 years of age, they all agreed that the boys' physical and moral welfare should be looked after in the home as far as possible. But he was afraid the tendency was to shift the responsibility for that from the home to the school. Other speakers had mentioned that students were unable to grasp the words used. He thought the fault lay with the elementary education. More attention ought to be paid to a man writing decently and putting a decent composition together and having a fair knowledge of simple arithmetic.

Mr. B. F. Sperring (Portsmouth) suggested that the committee who were going to deal with that matter should communicate with the dockyards, which had an excellent way of educating apprentices. They compelled all apprentices to attend schools two afternoons and two evenings each week for the first two years of their apprenticeship, and only the lads obtaining a certain percentage of marks were able to attend the school during the remainder of their apprenticeship.

The President, concluding the discussion, said that this was a very great subject and had led to a very useful discussion. The time at disposal would not allow of further remarks, and he would therefore put the resolution:

> "That the Council of the British Foundrymen's Association form a committee to investigate the matter with a view to reporting to the Association on the best means of assisting in the education of young foundrymen."

This resolution was carried unanimously.

Mr. J. W. Horne, replying on the discussion, said he must thank them for carrying that resolution. The whole intention of the Paper was not to bring forward his own opinions on education, which subject was far too difficult for him to tackle. His object rather was to group opinions from various quarters. There was only one thing he would like to reply to, namely, the remarks of Mr. Gimson with regard to the supervision of the boys up to the age of 18 years. They were obliged to take into account physical development. He was inclined to agree, although Mr. Buchanan was against him, that the whole trouble lay with compulsion in education. This compulsion, he considered, had taken away from the British working man the responsibility of the parent. Education was compulsory up to 14 years of age, and now they were reaping the results. He, as a Scotchman, regretted the day when education became free and compulsory in Scotland, because the Scotch parent was interested in the education of his child, and it was the exception rather than the rule to be otherwise. These were the reasons why, in the future, the Government would have to face the supervision of youths from 14 to 18 years of age. With regard to the Cincinnati system, Mr. Gimson must understand that it was only a certain number of apprentices who could with advantage be trained on that system. They must come up to a certain standard, and it was not always possible to get a sufficiency of boys up to that standard. He did not propose to go into the question of primary education; but he disagreed with Mr. Pilkington, because he was essentially a believer in training the boy's intelligence from the literary side. That did not necessarily mean over-burdening the brain, but if they did not train the literary side of a boy's intelligence they could never carry on successfully his scientific training. (Applause.)

Coking Practice in the South Wales District.

The next paper read was by Mr. R. H. Greaves, of the University College, Cardiff, on "Coking Practice in the South Wales District." Owing to considerations of space this will be published in our next issue.

At the conclusion of the discussion, the Convention adjourned until the next day.

Reception in the City Hall.

A party of ladies and gentlemen, numbering about 200, accepted the invitation of the Lord Mayor and the Lady Mayoress to a reception given in honour of the Convention in the magnificent City Hall, which is situate, like the University College and other new public buildings, in Cathays Park. The guests were received by the Lord Mayor and the Lady Mayoress (Sir John and Lady Courtis) in the Assembly Room.

Excellent musical entertainment was provided, and supper was served in the luncheon room, and the Lord Mayor and Lady Mayoress, before the resumption of the concert, conducted the guests through some of the principal apartments, the Council Chamber and the Lord Mayor's Parlour being particularly admired. The latter is a dignified and at the same time gracefully-designed room, and is adorned with some fine specimens of faience, sculpture, and other works of art, the gifts of eminent citizens.

While the guests were assembled here, the President of the Association (Mr. C. Jones) asked Mr. R. Buchanan, as the Senior Past-President, to propose a vote of thanks to Sir John and Lady Courtis for their hospitality.

Mr. R. Buchanan said that it had given the members of the Convention the greatest possible pleasure to experience the extreme kindness of the Lord Mayor and the Lady Mayoress. He could assure Sir John and Lady Courtis that they had all been delighted with their reception. (Hear, hear.) Not so many years ago a civic reception to the Association was an innovation, and he thought it augured very well for their Association that they should have this honour accorded to it. It had given the members the greatest possible gratification, not only at being received so hospitably, but also at finding such a recognition of the educative work which their Association was trying to do, a work which he believed they had accomplished in some degree, and hoped to carry to a successful completion. (Hear, hear.)

The vote was carried by acclamation, and acknowledged by the Lord Mayor.

Wednesday's Proceedings.

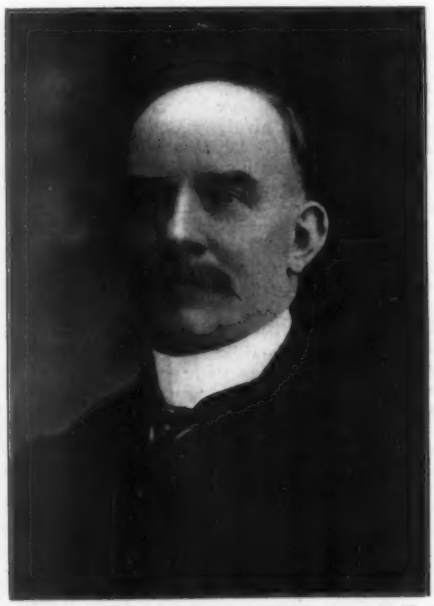
The second sitting of the Convention was held at the University on Wednesday morning, when the following additional members were in attendance:—Messrs. W. Gower (Birmingham), H. Aspinall (Manchester), W. H. Gould (Cardiff), J. G. Robinson (Halifax), T. R. Schofield (Manchester), W. Barningham (Manchester), and W. A. Young (London).

Mr. H. I. Coe, in a brief explanatory abstract, presented his Paper on "The Influence of Sulphur on Cast Iron." (See page 558 of this issue.)

The Influence of Sulphur on Cast Iron.

Mr. H. Pilkington said that what chiefly interested him in the Paper was the reference to Professor Turner's researches with regard to silicon, and the impossibility of high sulphur existing with high silicon. That was a very old story. Many years ago he had a controversy with Professor Turner on that point, and he supplied Professor Turner with evidence of the fact that high sulphur could, and did, exist with high silicon in pig-iron. He thought the best practical illustrations of that was in glazed or siliceous pig-iron.

In the ordinary way a siliceous pig-iron, of course, was very low in sulphur; but it was also very graphitic. There was also to be found in considerable quantities another iron which was considerably glazed, called silky forge; and if it were not for the fact that the fracture was obscured by



J. Weir, Vice-President of Newcastle-on-Tyne Branch of the British Foundrymen's Association.

the glazing, it would be seen that it did break with a forge fracture. That iron was a source of considerable trouble if it got into the foundry, as it was very hard and high in sulphur. There was plenty of evidence that high sulphur and high silicon (silicon up to 4 per cent.), did exist together in certain pig-irons. With regard to the increase of sulphur by remelting in the cupola, it was said in the Paper that most authorities agreed in giving 0.03 per cent. as the average amount of increase by each melting in the cupola. Conditions, however, varied, such as the sulphur in the coke and the sulphur in the scrap, and it was very difficult to determine the cupola increase in any particular case if these conditions were not known. The scrap itself also became accumulative in conveying sulphur to the casting; the iron having acquired a certain amount of sulphur in one melt, it came in again with every fresh charge of scrap, and this tended to increase the resulting sulphur. He would suggest that 0.03 as the average percentage of sulphur that came into the cast iron in the cupola through the coke was a very low figure. Mr. Coe mentioned that the bright inclusions found in certain bars, which were thought to be sulphide of manganese, but proved upon analysis to be extruded portions of eutectic, contained 3.93 per cent. of carbon. He (Mr. Pilkington) had had considerable experience with these bright globular inclusions. He had had them analysed and had observed that there was a considerably greater quantity of phosphorus in them than in the surrounding pig-iron. He wished again to emphasise the point that it was quite possible for high sulphur to exist with high silicon. One point that the author made was that sulphur, if it was in the metal, might rise to the top. He quite agreed that if such a charge as he had suggested, with high silicon, were left in the ladle in mass there must be a considerable decrease in the amount of sulphur that remained.

Mr. R. Buchanan thought that Mr. Coe was quite right in what he said as to the probable way in which the sulphur got to the iron in the carbide. Mr. Levy's theory was that the sulphur somehow surrounded the particles of carbide and acted as a kind of band, and so mechanically stopped the separating out of the graphite, which would otherwise separate out afterwards if that sulphur were not present. It was largely a mechanical effect—probably also a chemical one but practically a mechanical one. In conversation with Mr. Levy, he had pointed out to him certain facts which had come to his (Mr. Buchanan's) knowledge, and which did not agree with Mr. Levy's theory as to how the sulphur acted. Within the past fortnight he had come across the phenomenon again. A founder was making for textile work certain castings which had to be exceedingly soft. These grey-iron castings before annealing were perfectly fit to be filed, but when they came out of the annealing oven the outside had a white, hard skin, which a file would not touch. This skin was very much harder than that which was on the casting before annealing. The inside was perfectly soft, softer than the iron had been at first, but owing to the hardness of the skin the castings were of no use for the purpose for which they had been made. In such cases previously, he had suspected sulphur as the cause of the formation of this hard skin, and he found about 1½ per cent. of sulphur in the coke dust in which the castings were being annealed. It was quite obvious that the hard

H. A. J. Rang, Secretary of Newcastle-on-Tyne Branch of the British Foundrymen's Association.

skin was formed on the castings by the formation of carbide on the outside, and that was what might be expected to take place with a lot of sulphur dust round it. It was very doubtful, however, whether Mr. Levy's theory was correct, though it was desirable to investigate it. So far, however, he disagreed

with Mr. Levy's theory because he did not think it agreed with the facts. He remembered a consignment of pig-iron which had a mottled appearance, and which on analysis proved to have over 3 per cent. of silicon and 0.15 per cent. of sulphur. He had to use that iron very carefully indeed, and very little at a time. This showed that under certain conditions one could have both high sulphur and high silicon present. He would like to hear whether Mr. Coe has met with the occurrence of small blow holes (or as they called them pinholing) in any of his bars or tests, because he considered it to result almost wholly from the influence of the sulphur contained in the iron. He had little hesitation in saying that it did come from the sulphur, and he would very much like to know what Mr. Coe's conclusions on that point were. He thought it rather interesting to compare the tensile tests of bar 20 and those of bars 16 and 17, and the relations in those bars between the transverse and the tensile strengths. It was usually considered that with a high tensile strength there was a high transverse strength, and *vice versa*, but in bar 16 a tensile strength of 18¼ tons and a breaking strain of 28.5 cwts. were shown, whereas in bar 17 the tensile dropped to 12.24 tons, and the transverse went up to 30.5 cwts. This showed a great discrepency with the usual relations between the tensile and transverse strengths. But one could hardly draw conclusions from single tests, because of little incidental happenings which might account for the discrepancy. Still it did suggest that what was regarded as the customary relation between tensile and transverse did not always hold good in a casting. It had always been a source of wonder to him that an increase of the carbide, which was the hard constitutent, and which was usually considered also to be brittle, should up to a certain point result in an increase of strength. It was not obvious, on the face of it, how an increase in the proportion of a brittle substance could increase the strength of a body, and he would be glad to hear whether Mr. Coe had formed any conclusions as to how that came about. Of course, it was known that when the addition got beyond a certain point, weakness rapidly supervened, but up to that point there was no doubt that the addition of a hard, brittle substance did increase the strength. He thought the observations of Mr. Coe with regard to low carbide and silicon were worth noting, but he was not sure how far the results accorded with what might be observed in the irons they had to use in the foundry. Mr. Coe's irons were very low in phosphorus and silicon, and the carbons were all 3 per cent. or under, and that must have a remarkable influence on the tests and upon the relative influence of the sulphur and the silicon. It was rather interesting to note that in Fig. 3 there was the recurrence of what might be called the net-like formation which Messrs. Cook and Hailstone had shown to be always present in strong irons, and it was interesting to find that Mr. Coe's experiments confirmed what Messrs. Cook and Hailstone had done. (Applause.)

Mr. F. J. Cook said that he had read Mr. Coe's Paper with very great interest, and also with a great deal of pleasure, because it confirmed opinions which he had held for a very long time. The point he would like to emphasise—and he hoped that Mr. Coe had the idea of continuing this research further—was with regard to the paragraph in which Mr. Coe said: "A critical point as regards the percentage of sulphur appears to exist, at which the effect of the sulphur changes comparatively suddenly. The position of this critical point will change according to the silicon content." He agreed that what Mr. Coe said was absolutely correct. For a long time he (Mr. Cook) had been of opinion that there did exist what he might call an equilibrium point with regard to the percentage of sulphur in the presence of the carbon and silicon, and that that critical point had a very great bearing on the strength of the metal, and he believed also on its wearing properties, although he was not able to prove the latter by records of the actual wearing of parts of machinery. At any rate, he was quite sure that sulphur up to the critical or equilibrium point had a very great effect on the wearing parts of engines which were subjected to very high temperatures, such as 500 deg. C. For a long time he had held the opinion that for a soft iron which contained 1¼ per cent. silicon and 3 to 3¼ per cent. total carbon, the equilibrium point with regard to sulphur was 0.12 per cent. It was pleasing to him to see that bar 16 came up to that very closely. When those conditions prevailed a very strong bar was got, and that was also borne out by the fact that they had 18½ tons tensile with the sulphur at that very point. Mr. Buchanan had already referred to the net-like structure which Mr. Hailstone and himself had brought to their notice at Birmingham, and which was also emphasised in Fig. 3. He thought there was a very good field for Mr. Coe to conduct further investigation and to prove this critical point with varying amounts of sulphur and silicon. They knew that the silicon was a very great ruling factor in the quality of cast-iron, but he was quite of the opinion that for strong irons sulphur was also a very great factor. He must modify Mr. Buchanan's remarks with regard to the blowholes due to sulphur. Undoubtedly sulphur did cause blowholes, but it was one's own fault if one did get blowholes, even with irons containing sulphur as high as 0.12 per cent. It was entirely a matter of casting temperature. One might cast for long periods successfully with such irons, but the temperature must be high—not only the melting temperature but also the casting temperature, and then one would have no trouble at all with blowholes. (Applause.)

Professor Campion, whilst agreeing with Mr. Coe that it was absolutely necessary to get a good deal of information and to study very thoroughly the effects of various constituents of iron, hesitated to take as final the results recorded in the Paper, because, after all the experiments were not done under ordinary conditions. It seemed to him that there was need for something upon the lines of Mr. Coe's Paper, but to be done under actual commercial conditions. He himself had in hand a series of experiments as to the effect of various constituents on iron and these were being conducted as nearly as possible under actual working conditions. They were melting the irons in their small cupola and casting them in fairly large masses, varying the casting temperature and varying the several constituents. But instead of taking as a basis a washed iron, which one might call practically iron-carbon, they took a certain hematite iron and then varied one constituent at a time, keeping all the others, as far as possible, constant. He hoped by those experiments to get results nearer to those obtainable under actual foundry conditions, because cooling and casting conditions in the foundry were very different indeed from those in the laboratory, and cooling played a very important part in the actual properties of the metal. With the general material of the Paper he did not propose to deal. Many of the matters referred to required further investigation, although, generally speaking, he was somewhat in agreement with the points about high silicon and high sulphur. He thought most people had come across them in some form or other. He had not had experience in foundry iron of such high percentages as had been mentioned, but he had seen a steel-making iron, a hematite iron, which contained about 3 per cent. of silicon, and a somewhat high percentage of sulphur, and he thought this could be got just as much in foundry iron.

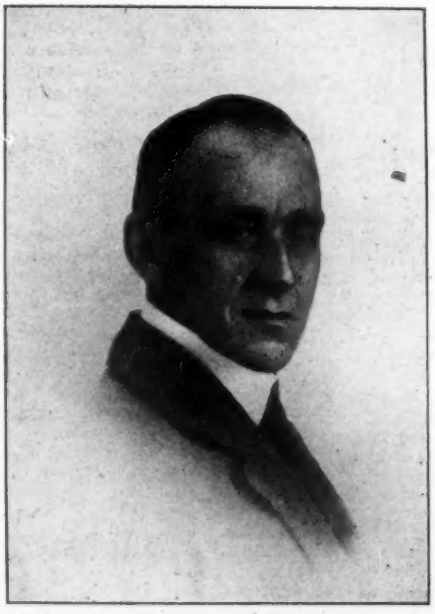
Mr. Buchanan, referring to what Mr. Pilkington

had said as to the percentage of sulphur gained by remelting in the cupola, mentioned some experiments he had made many years ago in the cupola with a certain brand of iron which he had had analysed, and using one lot of coke. He melted a given amount of pig-iron, using a given amount of coke, and after

J. Oswald, Retiring President of London Branch of the British Foundrymen's Association.

about a dozen tests, he found that the gain in sulphur on each remelting of the iron was 0.038 per cent. That was with a coke containing 0.7 per cent. of sulphur, which, of course, was fairly normal.

Mr. Coe, replying, said that he had learnt from the discussion on that Paper almost as much as he learnt while conducting the research it described. With regard to the questions as to the simultaneous presence of high sulphur and high silicon, he had referred to having 0.45 per cent. of sulphur with the silicon over 2 per cent. But—as far as he had gone—and he intended to investigate the question a little further—he had not met any decisive evidence as to the permanence of that iron sulphide in the iron when allowed to stand in the molten condition. In the case he mentioned, the iron was just melted in the crucible and stirred up and poured. The fracture of the iron and the condition of the carbon did seem to indicate that there was some association of the iron sulphide with the cast iron. His figure of 0.03 as the average gain per cent. of sulphur by remelting in the cupola was obtained from a general survey of the literature on the subject, included in which was Mr. Buchanan's Paper. He had not been in a position to do any work on that matter. It ought to be seen from his Paper that that amount of sulphur was taken up in each remelting, that is, if scrap was remelted again still more would be taken up. Dr. Stead had mentioned globular inclusions containing phosphorus. In the irons prepared for that Paper no phosphorus was present, and the globular inclusions consisted of the most fusible portions of the iron; in the present case, they were inclusions of the iron carbide pearlite eutectic. Mr. Buchanan's views as to Mr. Levy's theory were very interesting, but personally he (Mr. Coe) leaned to Dr. Stead's opinion, though he believed that Mr. Levy's views were partially correct, but he did not think they entirely accounted for the effect of sulphur. Both Mr. Buchanan and Mr. Cook had referred to the presence of blowholes when the sulphur content was high. When he commenced that research he expected to find blowholes occurring rather frequently, but he very seldom did find them. It must be borne in mind that the iron was melted under conditions very different from those which obtained in the cupola, where they had to consider the blast of air and the fact that some gases might be present which would possibly dissolve and afterwards be instrumental in producing blowholes. Even with a very high percentage of sulphur he found no evidence of blowholes. The point brought out by Mr. Cook with regard to a high casting temperature was very interesting to him, as he believed the same facts held in non-ferrous work. With regard to high carbon and low phosphorus, he was afraid that could not be avoided under the conditions of his experiments, but he was under the impression that an average foundry mixture usually contained about 3 per cent., or perhaps from 3 to 3.3 per cent. of carbon. He quite agreed any alteration in the percentage of carbon would exert its own influence on the character of the iron. With regard to the effect of phosphorus, he had thought it better to take the simple cases first, that was to abolish phosphorus, and consider only the influence of sulphur and the silicon. Then in a later research he might possibly go on to consider the effect of a silicon and sulphur with phosphorus or manganese or both present. He, like Mr. Cook, was struck by the resemblance



M. Riddell, Junior, Vice-President and Secretary (Pro. Tem.) of Scottish Branch of the British Foundrymen's Association.

between his Fig. 3 and the figures published by Messrs. Cook and Hailstone. But he would like to point out one difference. The netlike structure in his figure was a network of the iron-carbide pearlite eutectic, the lowest melting-point constituent in that particular series, whereas in Messrs.

Cook and Hailstone's figure the network was due to the solidification of the phosphide eutectic.

Mr. Cook: May I correct that? We also pointed out that it was not necessary for phosphorus to be present. We pointed out that the cementite alone would also take up this net-like structure, so that the network could exist without the phosphorus.

For Paper and illustrations see page 551.

Mr. Coe: I think in that case the view expressed in my Paper is confirmed by you.

Mr. Cook: I quite agree.

Mr. Coe said that he was very pleased that Mr. Cook's experience with respect to the effect of sulphur was confirmed by that Paper, and especially with regard to the critical point. In doing the actual work he found the evidence more definite than appeared in the Paper itself. Professor Campion's remarks were interesting and true. He (Mr. Coe) thought that a good deal of the work that had been done on cast irons lost some of its usefulness because the nature of the irons used as a base was sometimes not determined beforehand. Thus, frequently a certain effect was put down to one constituent when it was really due to other constituents in the iron. Therefore, he believed it necessary for a preliminary research to be done on pure materials before taking up the research on commercial materials.

The President, on behalf of the members, thanked Mr. Coe for his very useful Paper. (Applause.)

Discussion on "Moulding a Water Jacketed Cylinder for a Vertical Gas Engine."

Great interest was shown in the practical Paper by Mr. J. G. Robinson, of the Campbell Gas Engine Company, Halifax, on "Moulding a Water-Jacketed Cylinder for a Vertical Gas Engine." The Paper was given by the author in full, and was illustrated by an excellent series of lantern slides.

For Paper and illustrations see page 551.

Mr. F. J. Cook, in opening the discussion, remarked that it was very surprising, and it would have been more surprising a few years ago, that a firm should allow their foundry manager to come there to explain the methods by which they got such good results in their foundry. He was sure they all appreciated the spirit shown by Messrs. Campbell in allowing Mr. Robinson to tell them how the difficulties in casting such an important piece of machinery had been got over. (Applause.) The troubles were such as were patent to every foundryman who had had to do with casting cylinders for steam engines, and still more for gas engines. One point which appealed to him (Mr. Cook) was the question of the oil-sand. He was rather surprised to see so many irons shown as were seen in the water-jacket, because it was generally understood that with oil-sand cores they were able to do without so many irons. He himself did not find it necessary to use so many irons as Mr. Robinson showed, and for small cores, of course, irons were not used at all. Another point with regard to oil-sand cores was the danger of not having them properly dried. In that case the cores had a tendency to blow. He would like to know whether Mr. Robinson had any method of judging or testing whether or not his oil-sand cores were dry enough—had had sufficient of the oil expelled from them to enable them to be used with safety. Want of care in this respect was a source of serious trouble and danger. Would Mr. Robinson also tell them whether he had any particular method of mixing the oil; the efficiency of the mixing very largely depended on whether the sand was very wet or not. As the oil used for these cores was very expensive, one had to be very careful in using it lest the expense should be too high. One method he knew of making a very good blend of oil and water, and therefore cheapening the mixture, was to start with the dry sand. This was easy, as it could be dried in the core stoves. A known quantity of water was then taken and then the oil, whether linseed oil or sperm oil, was added. The oil and the water having been put into a separate receptacle, air was blown into it (where compressed air was available) through a ring pipe with holes in it, at the bottom of the receptacle. Thus they could be more sure of their mixture being always alike, as they would have known quantities of water and of oil properly distributed throughout the sand. A better mixture could be obtained by that method than by any other he had seen.

Mr. S. G. Smith (Chesterfield) complimented Mr. Robinson upon the clear, instructive, and interesting manner in which he had dealt with the subject. To the practical man, whether he was familiar with such work or not, procedures were always interesting, and he thought that form of bringing the foundry floor (so to speak) into a meeting-room should be encouraged, and take a larger part in both the annual and Branch meetings of the Association. He had been privileged to visit the works where Mr. Robinson was engaged, which made the Paper doubly interesting to him.

Mr. R. Buchanan said that he was anxious to know how the casting head acting down through the narrow neck of metal, was going to feed the heavier section which was under the lighter section. He had seen a cylinder of similar section to that shown which had sunk just at the top of the flange, and they put a feeding head on the next one cast like that shown by Mr. Robinson. He prophesied disaster, but he was wrong. Why it should have turned out all right he did not know, and he would like Mr. Robinson or someone else to tell them how that head was going to feed the body of the casting. With regard to the drawing of the main core bar, he would like to know whether Mr. Robinson depended on the straw burning, or was the core-bar tapered?

Mr. Robinson remarked that the core barrel was parallel; and he depended on the wood-wool bands round it burning out, thus loosening the bar.

Mr. Buchanan, referring to the chills, said that he was glad that Mr. Robinson had brought that question forward. The older school of foundrymen were horrified when a chill was spoken of, and began to think at once of hard, white iron. He thought it was about time both foundrymen and engineers—and especially engineers—disabused themselves of the idea that if they had any contact of metal with cast iron they were going to have about one-eighth or one-quarter inch of white iron. Mr. Robinson had shown them how to use these chills effectively. (Applause.)

Mr. Robinson, in replying, mentioned that Mr. Campbell when asked six or seven months ago for permission for that Paper to be given, not only granted permission, but also placed the works' photographer at his disposal, and had the slides prepared at his (Mr. Campbell's) own expense. (Applause.) With respect to the irons in the oil-sand cores, there were possibly more than were needed, but in an ironfoundry there was one rule which was not a bad one, namely, "It is better to be safe than sorry." (Laughter and applause.) It was not at all difficult to get these irons out and he did not think it worth while to have a less number, just for the sake of the trouble of putting a few more in. With regard to drying out the oil, they had no definite method, beyond what came by actual experience. A man got so used to handling these cores that they gave him no trouble. In the morning, if the cores were dry there would be very little steam arising from them. If steam was rising the cores were taken away and allowed to stand until they got somewhat cool, and they would dry out with a hard face upon them. If one could push a pocket-knife in them at all, one knew they were not sufficiently dried.

Mr. Cook: I quite agree that, as you say, when a core comes out of the oven not properly dried it will smoke; but I have known cores come out without smoking, and then blow. We allow them to cool down and then black them, and put them back into the stove, and if they are not properly dried, you soon

Fred. Penlington, President of Lancashire Branch of British Foundrymen's Association.

see smoke coming out. In that case we let them stay in a little longer.

Mr. Robinson, dealing with the question of mixing, said that the proportion of oil to water used was 1 to 30. They had no elaborate machinery for mixing. As in many other places, they had to mix the sand with water in a trough. They then added the oil, using one pint to five shovelfuls of sand, or, if the core was not required very strong, six shovelfuls. They found that the oil seemed to mix better with the moist sand. That was why they mixed the water with it first. When the oil had been added the sand was turned over with the shovel and then put first through a ½-in. and then twice through a ¼-in. riddle. With regard to the feeding-head, he thought the benefit was due to the fact that between the thick part and the head the metal was kept warm by the thickness both top and bottom. He mentioned the chills round that flange to show they did not trust absolutely to the feeding-head. A chill was put inside all round the flange. He had tried casting without chills both top and bottom, and he was able to get a fairly good result on some cylinders because round that neck there was a thicker section. Where he had a sufficiently thick section the casting came out all right; but with these cylinders, which had a thinner section, he could not get the desired result. Therefore, he did away with the feed, and used chills. He used to have two risers, feeding down both; but in the flange shown he did not use the feeding-head to either, but trusted to the chills cooling the section of metal. At one time he used the chills round the top flange only, and not round the bottom. He found then that just below the flange the casting was very badly drawn. The metal which was in the thick part at the bottom and also up towards the flange, seemed to have remained in a molten condition after the chills inside the flange had taken effect. Then as it had solidified, commencing at the bottom, it appeared to have drawn from the part directly above it, until it reached towards the part which had been chilled. This having solidified, would not feed the part below it, and thus about 3 in. of the depth was left in a badly-drawn condition. By using the bottom chills, solidification commenced sooner, and was practically uniform all the way up. The effect of that chill round the thick part of the flange was not to cause the formation of a hard, white skin, as Mr. Buchanan remarked. The chill was only 1¼-in. thick. All it did was to cause the metal round about it to solidify quickly, and whatever chilling effect it had was counteracted by the annealing effect of the thickness of metal behind it. There was not sufficient body in the chill to cause it to strike back. It only closed up the grain of the metal and did not cause the formation of white iron in any appreciable thickness. (Applause.)

Modern Brassfounding.

The President said that they had a Paper on "Modern Brassfounding," by Mr. H. S. Primrose, of Glasgow, but as the author was not there, they would take it as read. The Paper was open for discussion, but it would be rather awkward to discuss it in the author's absence, as they would have to wait until next year for his reply. The Secretary had received a letter from Mr. Primrose promising to answer in writing any questions which might be asked about the Paper.

This Paper appears on page 544 of this issue.

Votes of Thanks.

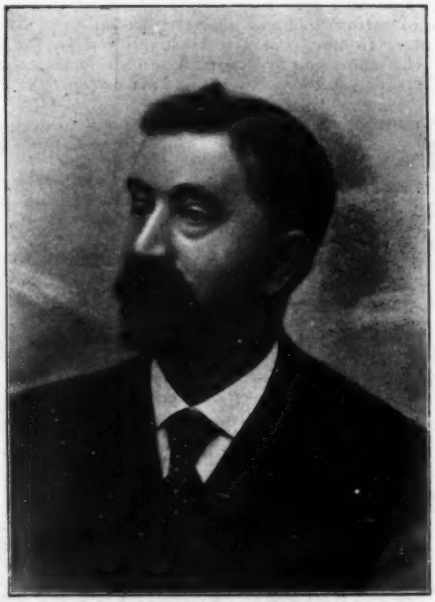
Mr. Pilkington said that he had very great pleasure in moving that they give hearty thanks to the

J. Simkiss, Vice-President of the Lancashire Branch of the British Foundrymen's Association.

readers of Papers. They had had excellent Papers and valuable discussions. It was a source of satisfaction to all of them that they had had two or three practical Papers, which had interested the general body of members more than had some of the Papers they had had at previous Conventions. (Hear, hear.)

Of course he did not for a moment depreciate the reading of theoretical Papers, which were equally valuable in their way; but in an Association like theirs, it was important to have as many as possible of the Papers of a practical character, Papers which, as had been said, brought the moulding shop right into the room. (Hear, hear.)

A unanimous vote of thanks to the Governors of the University College, and also to Principal Griffiths, and a similar vote of recognition to the Reception Committee of the Association concluded the proceedings of the Convention.



HUGH CAMPBELL, M.I.MECH.E., PRESIDENT OF THE HALIFAX BRANCH OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

In the afternoon the members visited the Bute Docks, and in the evening the docks, harbour and hydraulic houses at Penarth.

As is customary, the Thursday was devoted to a pleasure excursion. The Reception Committee had organised a picnic to the Wye Valley, a district unsurpassed for its scenic beauty and historical interest. Though the unsettled weather was a great drawback, the excursion proved most enjoyable.

The Melting Points of Firebricks.

BY C. W. KANOLT.

A melting point can be precisely and rationally defined only as the temperature at which a crystalline or anisotropic phase and an amorphous or isotropic phase of the same composition can exist in contact in equilibrium; but so complex a mixture as an ordinary firebrick usually has no single definite melting point according to this definition, since several anisotropic phases may be present, all differing in composition from the isotropic phase produced by fusion. We can then only select the temperature at which the transition from a rigid to a fluid state seems most distinct. The writer has taken as the melting point the lowest temperature at which a small piece of the brick could be distinctly seen to flow.

The temperatures were determined by means of a Morse optical pyrometer of the Holborn-Kurlbaum type, which was sighted vertically downward through the glass window. The carbon-filament pyrometer lamp was calibrated by two methods. In the first calibration it was sighted into a platinum resistance furnace in which black-body conditions were obtained, and the temperature of which was measured by platinum platinum-rhodium thermo-couples. These thermo-couples had been calibrated against the freezing points of pure metals. In the second calibration the lamp was calibrated against the freezing points of metals directly, without the intermediation of thermo-couples. The metals used were copper, silver, and the copper-silver eutectic, which freeze at 1,083 deg. C., 961 deg. C., and 779 deg. C., respectively. The metals were melted in the vacuum furnace in graphite crucibles, the pyrometer being sighted into a thin-walled graphite tube inserted in the metal. The pyrometer readings corresponding to the freezing points were determined by means of cooling curves.

As the melting points to be measured were above the working limit of the pyrometer lamp, an absorption glass was interposed between the pyrometer and the furnace. The true temperatures were then found from the apparent temperatures measured through the glass, by means of the equation.

$$\frac{1}{T_2} - \frac{1}{T_1} = A,$$

where T_1 is the absolute temperature of the furnace, T_2 is the apparent temperature observed through the glass, and A is a constant. The value of A was determined by calibrations at various temperatures. A small correction was also applied for the absorption and reflection of the glass window of the furnace.

The samples, which were from one to two centimetres in diameter, were heated at the rate of about 10 degrees per minute when near the melting point. It was found that in the case of certain bricks made of heterogeneous material of relatively low melting point, the melting points were slightly higher after six hours' heating to 1,550 degs., apparently as the result of the gradual running together of dissimilar particles to form a mixture having a higher melting point than the most fusible of the original materials.

The results are summarised in the following table:—

Material.	Number of Samples.	Melting point Centigrade.
Fire clay brick	.. 41	155° to 1725° mean 1640°
Bauxite brick ..	.. 8	1565° to 1785°
Silica brick ..	.. 3	1700° to 1750°
Chromite brick	.. 1	2050°
Magnesia brick	.. 1	2165°
Kaolin	.. 3	1735° to 1740°
Bauxite ..	.. 1	1820°
Bauxite clay ..	.. 1	1795°
Chromite ..	.. 1	2180°
Pure alumina ..	.. —	2010°
Pure Silica ..	.. —	1750°

The value 1,750 degs. given for silica is not the true melting point, but represents approximately the temperature at which the silica flows distinctly. It was found that silicon carbide does not melt below 2,700 degs.; it becomes unstable at much lower temperatures.

The Future of the Crucible Furnace.

Dr. Nachtweh, in the course of a Paper before the German Foundrymen's Association recently, discussed the improvements in the crucible process through the substitution of oil fuel for gas, with particular mention of the Rousseau furnace with special air feed, and the Durlacher tilting furnace, etc. In conclusion, he expressed the opinion that if the crucible furnace is to maintain its prestige in competition with other types, it will be advisable to employ designs enabling the crucibles to be tilted with the furnace, so as to prevent the injurious action of fluctuations of temperature on the material of the crucible and thus increase the working life of the latter.

Modern Brass Founding.

By H. S. Primrose,* M.I.M.

In modern brass founding the chief considerations to be kept in view are economic working and scientific control. The former is largely brought about by the adoption of various labour-saving devices, which reduce most of the operations to mechanical repetition, and a systematic lay-out of the plant which allows of the metal passing through the various stages of treatment in a straightforward direction. The control of the metal must be complete, beginning with the raw material and tracing it through all departments until it is sent out as a finished product. This scientific control should deal not only with the chemical composition but also with the physical tests, and, wherever possible, with the microstructure in addition.

H. S. Primrose, M.I.M.

It must be stated at the outset, in order that the term "brass-founding" may not be misunderstood, that the principles and practice detailed in this Paper deal first of all with what is really a bronze, technically known as Admiralty gunmetal, and containing 88 per cent. copper, 10 per cent. tin, and 2 per cent. zinc, according to specification. The details of working are, of course, equally applicable, with the necessary modifications, to the founding of true brass containing only copper and zinc.

Lay-Out.

The important point to be considered in designing a brass foundry is the provision of ample light and ventilation, and this is best accomplished by having high roofs copiously glazed, and provided with numerous openings through which the fumes and gases can escape readily. Such an arrangement is shown in Fig. 1, which illustrates a bay of a foundry used for moulding, assembling and pouring heavy casts. Poor ventilation in brass foundries is highly injurious to the health of the workmen, and the employer who is interested in the welfare of his employés will give the subject of ventilation careful consideration, and also install good sanitary arrangements. In many of the most up-to-date foundries all the employés are provided with lockers, and a sufficient number of wash-basins are provided for their use. The expense of these arrangements quickly repays itself by the increased efficiency of the operations performed under healthful conditions.

Fig. 1.—Bay in Brass Foundry.

Furnaces.

The type of furnaces to be used will depend upon the class of metal employed and the size of the castings to be made. For small gunmetal work the ordinary coke-burning crucible furnace is suitable where the output is not large, but for larger work it is advisable to have a reverberatory furnace of convenient size. The pot-fires are best arranged in a battery placed at floor level, in front of which are the ash-pits covered by a grating on which the melters can stand, and behind the fires the individual flues run into the main flue connected with the stack. A convenient arrangement is shown in Fig. 2, which illustrates a battery comprising 17 furnaces, each large enough to take crucibles holding 240 lbs. of metal. These are placed contiguous to the metal store, moulding floor, and dressing shop.

At the back of the metal store may be placed the platform at the side of the air furnaces, illus-

*Metallurgist, Messrs. G. & J. Weir, Limited, Cathcart.

trated in Fig. 3, in front of which is arranged the moulding floor and casting bed for heavy work. The drying stoves and dressing shop are also within short range of the furnaces, and opposite them may be

FIG. 2.—COKE-FIRED POT FURNACES FOR BRASS-MELTING.

situated a large heating furnace for dealing with large scrap which requires to be broken before charging into the air furnaces. The furnaces shown are of 5 and 7½ tons capacity, both being heated by splint coal.

Moulding Shop.

Moulding machines are now almost universally used for small duplicate work, and are chiefly of the stripping-plate variety, shown in the background of Fig. 4. For heavier work plate-moulding is now very general, the pattern being made in several parts which can be fixed on the plates. The moulding boxes are lowered over these, rammed up, finished, and thoroughly dried in the stoves. Fig. 5 shows the ramming up of a box on a plate. The various parts of the mould are collected, the cores put in and fixed, and the job closed and bolted together, and then cast on end.

FIG. 3.—AIR FURNACES FOR BRASS-MELTING.

For cleaning up the moulds, compressed air is highly advantageous, and should wherever possible be led to every part of the foundry; it is certainly much more efficacious than the old-fashioned bellows. The stove accommodation for drying large and small moulds must be very extensive, and Fig. 6 shows a good form of double stove which is fired from the side by char-fires. Smaller stoves must also be provided for the drying of cores, the heating in this case may be done either by gas or char-fires.

Whilst as a general rule it is advisable to carry out the casting of large work in dry-sand moulds, it is permissible to execute most of the small work in green-sand. Sands which have stood the test of

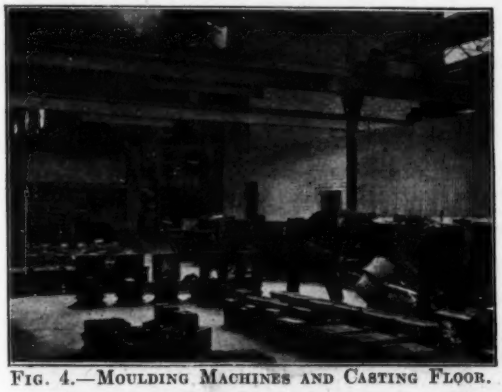


FIG. 4.—MOULDING MACHINES AND CASTING FLOOR.

long service for this work are "Erith" and "Scotch Rock," the latter being largely used for dry-sand work, the Erith being highly suitable for green-sand moulding. For facings, it is customary to use good blacking in the dry-sand moulds, but more often the green-sand work is dusted with plumbago or terra-flake. Large barrel cores are made up of loam and straw, and for small intricate cores a mixture of finer sand with molasses and flour gives good results, being strongly binding, porous, and easily removed.

Mechanical Appliances.

Each main bay should be served with at least one overhead electric crane, capable of rapidly lifting

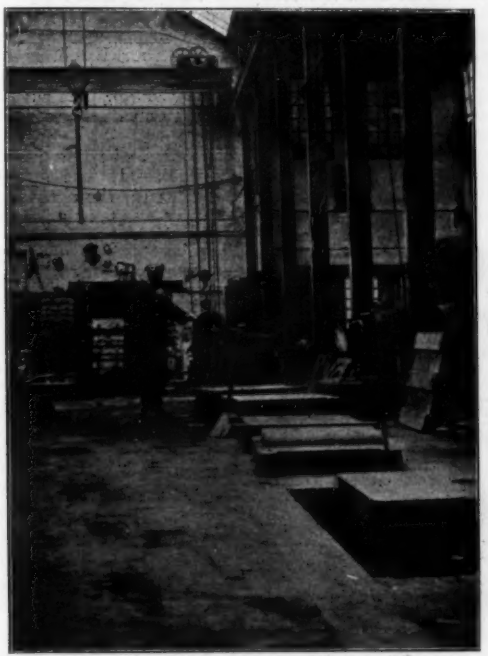


FIG. 5.—PLATE MOULDS FOR HEAVY WORK.

and transporting the heaviest moulds to be dealt with, and they can also be made to handle the large ladles used for heavy casts. Side bays can be fitted

with small overhead hand cranes, as well as hydraulic cranes to operate smaller work and aid in the lifting-out operation at the pot fires.

For transporting metal, small moulds and finished castings, a narrow-gauge tramway should be led throughout the shops, and the bogies run on this may be made to serve other useful purposes. For cutting, riddling and mixing sand, electric appliances are largely in vogue, and possess special advantage in dealing with large quantities.

PRACTICE.

Pot Fires.

In working the crucible furnaces, it is convenient to have the charges carefully weighed out and

FIG. 6.—LARGE DOUBLE-CHAMBER DRYING STOVE.

stacked at each fire ready for charging and melting. By suitably arranging the draft so as to get as complete combustion of the coke as possible, a good melter is able to take off at least four 160-lb. heats from each of nine furnaces in a working day of 9¾ hours, and those working with 240-lb. pots should be able to get out at least three melts from each of eight furnaces in the same time.

There are three important points to be taken into account in good melting practice:—(1) The length of time the metal is in the furnace; (2) the character of the covering or flux; and (3) the temperature of

FIG. 7.—CORNER OF DRESSING SHOP.

melting and casting. The time of a melt depends chiefly on the weight of the charge, and with a bright fire it should be kept as short as possible consistent with the complete fusion and mixing of the constituents, as prolonged "stewing" only tends to increased absorption of gas, which causes blowholes when the metal solidifies. One of the best coverings for rich copper alloys is ground glass, which possesses the advantages of simplicity and cheapness, and this is generally more efficacious in protecting the molten metal than the so-called "patent" fluxes. When the pots are drawn and carefully skimmed, they are covered with a circular iron lid with a small pouring opening, and this saves most of the objectionable zinc fumes which would otherwise be given off copiously. The fuel used in melting is about 44 per cent. of the weight of metal.

Air Furnaces.

The proportions of the charges for these furnaces are weighed out according to the composition of the

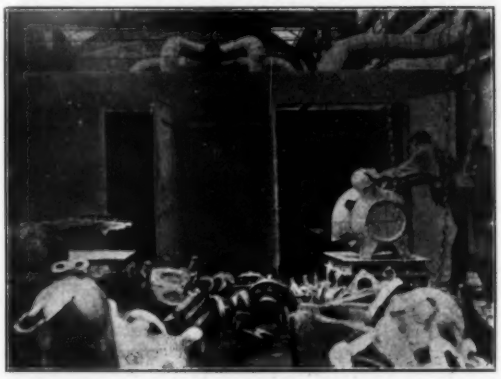


FIG. 8.—SAND-BLAST APPARATUS.

alloy required, and the material is collected on the charging platform. The greater part of the charge being made up on the inclined bed of the furnace, the fire is started in the forenoon, and charging is completed by noon. With a 7-tons charge the metal is ready for tapping about five in the afternoon, when the requisite tin is added and after thorough rabbling and reheating, the charge is ready for tapping in another half-hour. It is found advisable not to draw all the metal off at one time, but to split the tap up into three lots of about 50 cwts. each, rabbling between each to minimise segregation. Prior

FIG. 9.—PAN MILLS FOR RECOVERING METAL FROM ASHES.

to casting, the metal in the ladles should be carefully skimmed and covered with a layer of charcoal. The fuel consumption amounts to about 20 per cent. of the weight of the charge

Dressing Shop.

After the castings have been knocked out of the boxes, they are then immediately run into the dressing shop, which should therefore be placed as near to the casting floor as possible. In addition to the ordinary hand tools, very useful fittings are heavy sprue-cutters, band saws, pneumatic chipping hammers, and grinders, which may be arranged compactly as shown in Fig. 7. For an easy method of removing cores, and also for imparting a splendid finish to the castings, a sand-blast plant is almost a necessity. This plant has many advantages, and for large outputs has almost completely replaced the hand-dressing. Fig. 8 shows a two-compartment sand-blast apparatus for dealing with all classes of work.

Waste Recovery.

The large scrap from the dressing shop is generally clean, and consists of runners and fins from the castings, the pouring heads having been dealt with previously on the casting floor. This scrap can be sent back direct to the metal store and used over again in making up the furnace charges.

It is an important economical consideration to systematically collect all the pot-fire ashes, crucible-furnace and ladle skimmings, as well as the dust from the dressing shop. Riddling recovers the larger pieces of metal, but it is advisable, especially

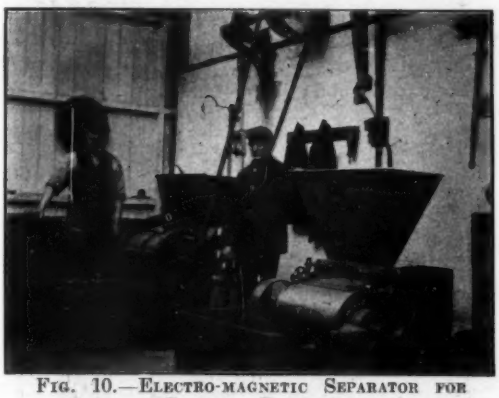


FIG. 10.—ELECTRO-MAGNETIC SEPARATOR FOR CLEANING BORINGS.

with the furnace ashes, to crush these with water in a special form of inclined pan mill with heavy grinding balls. The metal is left in nodules in the pans, whilst the finely-powdered ashes and small metallic particles are washed over and collected in a settler for subsequent sale. Fig. 9 shows such an arrangement which is often accountable for a recovery of 25 per cent. of the weight of the ashes as valuable material.

In cases where an engineering shop is connected with the foundry, it is highly advisable to keep the borings and turnings as clear as possible of iron and steel, and further to ensure complete removal of any chance contaminations by passing the metal through suitable electro-magnetic separators, two of which are shown in Fig. 10.

CONTROL.

Chemical Analysis.

For the accurate control of a brass foundry it is essential to have a well-equipped metallurgical and testing department, especially when the products have to conform closely to specification. Accurate knowledge of the allowances to be made in melting must be ascertained, and the amount of oxidation and volatilisation losses under the particular conditions of working must be determined in order to maintain a uniform composition of the resulting alloy. All scrap metal bought in should be melted, cast into ingots, and stacked in lots according to their analyses. The best results are only obtainable by making up the proportions of the charge constituents from the laboratory analysis, and in order to keep a thorough check on the resulting melts it is advisable to have these analysed also. All raw material, such as copper, tin, zinc, scrap, etc., should be bought to analysis, and carefully checked on delivery to ensure that it conforms to the specification. Where it is not possible to purchase on this basis, the material ought to be carefully analysed, and mixed accordingly.

The cost price of an alloy is largely determined by the price of the component parts, and when these differ considerably in value, even a slight variation in the alloy composition increases its cost. With copper at 6d. per lb., and tin at 1s. 8d. per lb., a true gunmetal of 90/10 composition would work out at 61s. 8d. per 100 lbs., but if, by mixing anything other than pure metals without knowing the analysis the tin content is increased to 11 per cent. then the

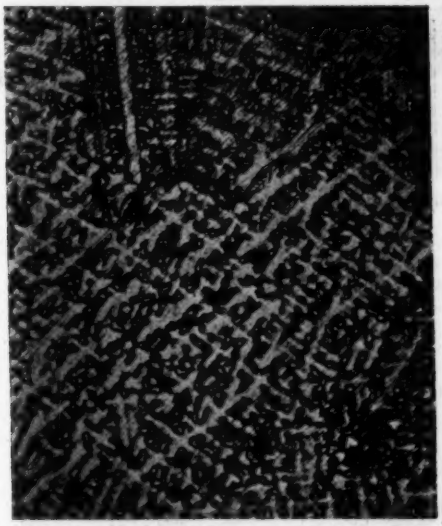


FIG. 11.—MICROSTRUCTURE OF GOOD GUN-METAL. MAG., 30 DIAMS.

resulting alloy would cost 62s. 10d. per 100 lbs. Such a variation may quite easily occur in practice which is not controlled by chemical analysis, and for a melt of 20 tons per week the loss would amount to £26, which is equivalent to £1,350 per annum. It is evident that in this and similar cases the cost of chemical control soon pays for itself several times over.

Another fruitful source of loss in a brass foundry is the copper carried by the refuse of various kinds, such as ashes, skimmings, floor sweepings, broken crucibles, etc. It is not always possible to erect plant in a foundry to recover the metallic portion of this waste, but it is certainly advantageous to dispose of it according to the copper content as determined by sampling and chemical analysis, and thus obtain a proper value for the material.

Physical Testing.

The most important physical testing to be done is with the cast metal in order to ascertain if it is up to the standard required, and sometimes this is

able to detect material which, although correct in chemical composition, is faulty in structure and therefore unsuited for service. When such tests show low results, the fracture may reveal a possible source of the trouble, but in many cases it does not, in which case it is necessary to adopt some other method of investigation.

In addition to the physical tests of the alloys, it pays to make examination of the various refractory materials, such as firebricks and fire-clay, used in the furnaces. Also the various moulding and core sands should be tested, besides by analysis, for fineness, binding qualities, refractory properties, and porosity. Crucibles are an important item of expense, and every batch ought to be tested for strength and durability. The plumbago and blacking used for facings often cause trouble in practice unless carefully tested for impurities as well as volatile matter, ash and carbon content. It is important to keep a check upon the heating power of the fuel used, and the coke used must be one low in sulphur and ash, and not addicted to clinkering.

Microscopical Investigation.

Within the last few years great progress has been made in the examination of the micro-structure of alloys, and this science of metallography is becoming a most valuable aid to the foundry metallurgist. It is rapidly replacing the older method of judging by fracture, and is without doubt a more certain guide to the foundryman who wishes to escape the repetition of serious failures due to causes other than change of chemical composition.

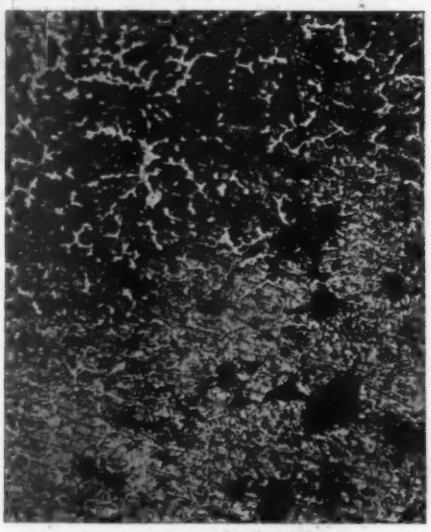


FIG. 12.—MICROSTRUCTURE OF GUNMETAL, SHOWING DEEP-SEATED GAS HOLES. MAG. 60 DIAMS.

The temperature of melting and pouring has a great influence on the strength of gunmetal castings. The chief cause for the variations which occur in the quality of the metal is the different rates of cooling through the molten condition and complete solidification. By pouring at a suitably high temperature, which depends upon the work in hand, the sand of the mould becomes highly heated, so that the freezing of the metal is slower than if the metal is cast "dull," and hence the crystals have time to grow into a good strong interlocking structure. This formation is well shown in Fig. 11, which is the photo-micrograph of an Admiralty gunmetal test-bar from a casting poured at the temperature of 1,100 deg. C., and slowly cooled. The tensile strength of this was 16 tons per sq. in. with a 24 per cent. elongation on 2 in.

Blow-holes are often troublesome in gunmetal castings and very materially reduce the strength. They may be due to a variety of causes, amongst which are dampness in the mould, gases either entrapped in the mould or dissolved in the metal, and metallic oxides partly dissolved or mechanically mixed with the metal. They are often so small as to escape detection unless under the microscope, and this examination most clearly reveals their distribution and the most probable source of the trouble. When this is known, the remedy is easily found. Fig. 12 shows one type of blow-hole deep seated in the metal, and evidently due to gas inclusions, which leave the cavities quite clean but so destroy the continuity of the structure that the interlocking of the crystals is diminished and the tensile strength much lowered, even though, as in this case, the chemical composition be right and the metal properly cast.

When the blow-holes are sharply defined but confined to the outer portions of the casting, they are more likely to be due to steam generated within the mould, and this produces a local chilling which completely alters the structure, as seen in Fig. 13. This is the micro-structure of a casting of perfectly satisfactory gunmetal by analysis, but which in this condition only stood a tensile strain of 5 tons per sq. in. A simple remelting was sufficient to bring this metal right, and Fig. 14 shows the improved structure brought about in this way; the tensile strength being in this way increased to 16 tons per sq. in.

FIG. 13.—MICROSTRUCTURE OF GUNMETAL, SHOWING STEAM HOLES NEAR SURFACE. MAG. 30 DIAMS.

The pyrometer is of great service in determining the temperature of the metal before pouring, but it is not practicable to observe the rate of cooling of each casting and attempt to regulate it. As gunmetal cools from fusion it passes through three distinct stages before it reaches normal temperature. In the first place a solid solution of copper with a little tin in it separates out, and this is known as alpha (α) constituent, which is soft and ductile. As

further cooling takes place the remainder of the metal solidifies as a second constituent which is a solid solution of copper containing a larger amount of tin, and this is known as the beta (β) constituent. The alloy is now completely solid and consists of primary crystallites of alpha with areas of beta in the interstices. The beta constituent, however, is not stable, and as the temperature falls to about 500 deg. C., it breaks up into a mixture of alpha constituent and delta (δ) constituent, which is a compound of copper and tin, having the formula Cu_4Sn. This is rich in tin (about 33 per cent.) and corresponds very closely to speculum metal, which accounts for its hard, brittle nature. The alloy is stable at ordinary temperature and now consists of a mixture of primary alpha crystallites, darker-etching littoral zones of the same constituent, in which is embedded the hard delta constituent which forms a eutectic structure with the secondary alpha, and remains white on etching. Such a normal structure got on slowly cooling a gunmetal casting is shown in Fig. 15, and illustrates the uniform distribution of

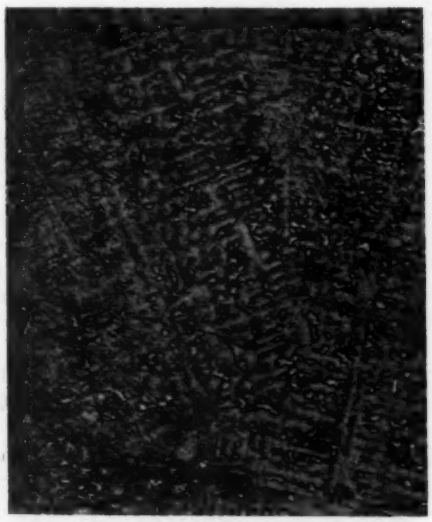


FIG. 14.—MICROSTRUCTURE OF GOOD GUNMETAL, SAME AS IN FIG. 13, REMELTED. MAG. 60 DIAMS.

the white eutectic areas, completely surrounded by the soft alpha constituent. A test bar cut from this metal stood 16 tons tensile strength, and showed an elongation of 24 per cent. on 2 in. For comparison, Fig. 16 is reproduced to show how improper cooling can diminish the primary crystallites of alpha-constituent, and cause it to be almost surrounded by the white eutectic areas. The physical tests of this material showed little diminution in the tensile strength, but the elongation was very adversely affected, being only 9 per cent. on 2 in.

The enormous value of the microscopical examination must be clear from even these few examples, and in the last-quoted case it suggests that a remedy for the low elongation results could be found by a suitable annealing of the metal above the temperature of 500 deg. C., in order to promote the growth of the primary alpha-crystallites and the absorption or balling-up of the eutectic areas into a uniform and less harmful distribution. In fact, the more completely these eutectiferous areas can be removed, the better the alloy becomes, and without doubt the correct solution of most of the common corrosion troubles lies in the direction of completely eliminating the eutectic from the alloy.

The author takes this opportunity of expressing his thanks to Messrs. G. & J. Weir, Limited, of Cathcart, for their kind permission to publish these observations and photographs of their Holm Foundry, as well as the photo-micrographs made in the course of testing.

FIG. 15.—MICROSTRUCTURE OF GOOD GUNMETAL, SHOWING ISOLATED EUTECTIC AREAS. MAG. 240 DIAMS.

Appendix I.

Example of a 7-ton Air-furnace Charge Sheet.

Cast No. 721.

Date, June 3, 1912. Charge of No. 1 Admiralty Gunmetal.

Charge.		Copper.		Tin.		Zinc.		Lead.	
Material.	Weight. cwts.	Per cent.	Cwts. per cent.	Per cent.	Cwts. per cent.	Per cent.	Cwts. per cent.	Per cent.	Cwts. per cent.
Shop Scrap	20	87.8	1756	9.5	190	2.0	40	0.7	14
Bought-in Scrap	59	85.5	5044	8.5	501	5.0	295	1.0	59
Machine Borings	20	87.7	1754	9.5	190	2.0	40	0.8	16
Copper Ingots	36	100.0	3600	—	—	—	—	—	—
Tin Ingots	5	—	—	100.0	500	—	—	—	—
Total	140		12154		1381		375		89
Average (Calculated Analysis).		86.8		9.87		2.7		0 63	
(Actual Analysis)		87.9		9.5	—	2.0		0 60	

Physical Tests.

Bar No.	Diam. inches.	C.S.A. Sq. In.	Tons.	Tons per Sq. In.	Elongation on 2 In.	Per cent.
1.	51/64	0.5	8.1	16.2	0.48 in.	24.0
2.	,,	0.5	8.3	16.6	0.44	22.0

Remarks.

Condition of Metal.—Clean and hot, cast about 1,100 deg. C. Three taps, each about 50 cwts.

Time of Melting.—Charged, 10 a.m. to 12 noon; tapped, 4.30 p.m.—6½ hours.

Fuel Consumption.—30 cwts. (Splint coal).

Appendix II.

Specification of Admiralty Gunmetal.

Composition.—Tin, 10 per cent.; zinc (max.), 2 per cent.; copper, remainder; impurities, nil. All copper is to be of approved quality. A deviation of more than 1 per cent. in the specified composition is sufficient to condemn the material.

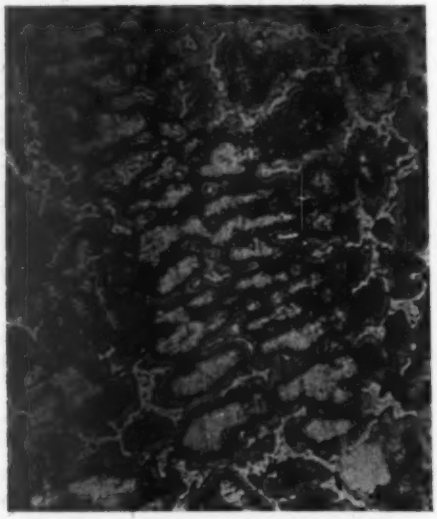


FIG. 16.—MICROSTRUCTURE OF GUNMETAL, SHOWING BRITTLE ARRANGEMENT OF EUTECTIC AREAS. MAG. 240 DIAMS.

Tensile Tests.—The test pieces taken from the casting have to stand the following tests:—Ultimate strength, not less than 14 tons per sq. in.; elongation on 2 in., not less than 7.5 per cent.

General.—The castings are to be sound, clean and free from blow-holes.

Bronze Statue of a Miner.

We illustrate herewith a magnificent model of a miner which has been presented to the Batley Park Museum by a gentleman who desires to remain anonymous. This gentleman has been so pleased with the fine collection of exhibits which has been got together, thanks to the enthusiasm and energy displayed by Mr. Walter Bagshaw, J.P. (hon. curator), that he has shown his sympathy with the object by presenting to the museum a bronze figure representing the coal-getting industry, and in making the idea known to Mr. Bagshaw, said he would like it to be of such a character that it might impress the working-man, enabling him to realise that the man who earned his living by "the sweat of his brow," might not only be a man, but a gentleman.

With these facts in mind, Mr. Bagshaw approached Messrs. Elkington & Co., art metal workers, of Birmingham, who undertook to produce a work such as might be a credit to the firm, and worthy of being handed down to posterity The work produced is not only an achievement in art, but it is also a fine representation of the best type of British workingman, suggestive of strength and energy and true manliness. It shows a miner in the ordinary working dress adopted locally; he is carrying his pick over his left shoulder, and his safety lamp in his right hand. The figure is 2 ft. 6 in. in height, and

BRONZE STATUE OF A MINER; PRESENTED TO BATLEY PARK MUSEUM.

stands on a block of coal, 2 ft. 6 in. high and 15 in. square. The block of coal rests on a marble slab, 2 ft. 6 in. square and 6 in. thick. At the base of the model there is a laurel wreath. The model rests on a wood pedestal, 2 ft. 6 in. high, and stands altogether over 8 ft. high. Attached to the block of coal is a silver plate bearing the following inscription from Carlyle:—"The mandate of God to his creature man is work. All true work is sacred. What man can do is his greatest ornament, and he always consults his dignity by doing it." The statue was unveiled last month by the Mayor of Batley.

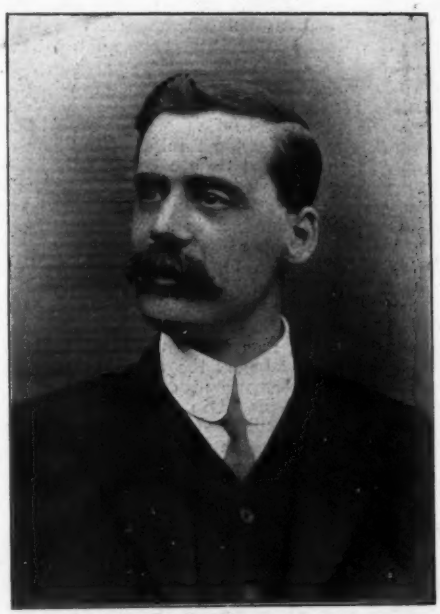
Moulding a Water-Jacketed Cylinder for a Vertical Gas Engine.

By J. G. Robinson (Halifax).

The title of this Paper is somewhat misleading, as it is not the writer's intention to enter into a detailed account of the actual moulding operations involved in the moulding of a water-jacketed cylinder. Such an account would obviously be a waste of time at a meeting of foundrymen.

My purpose is to describe the methods adopted at our works to secure sound and clean castings, and by means of slides prepared from photographs of a mould in the different stages of its construction, it is hoped to make this quite clear.

The cylinder under consideration (Fig. 1) is one of four which go to make up a 350-b.h.p. gas engine. The diameter of the bore is 17 in., the overall length 5 ft. 1 in.



J. G. Robinson.

By way of prefatory comment, I may point out that to the uninitiated and inexperienced certain difficulties in the making of patterns and core boxes and in the making and casting of the mould may appear very formidable, whereas to the less critical these difficulties will be non-apparent. That there are serious obstacles to be overcome will be well known to one who has had experience of this class of work, but he knows equally well how to avoid the pitfalls ever awaiting the unwary.

As a result of exhaustive experiments, we have adopted the following method as productive of the best result. There will be noticed a variation in the thickness of the metal at the point where the flange is connected with the inner and outer walls of the cylinder, and also at the opposite end, where solid blocks are cast in to receive the studs for attaching the end cover. During machining operations these two points have been found to exhibit a spongy nature, and have proved the most prolific source of trouble, which has been overcome by the use of chills and a suitable mixture of metal.

The mould is made in dry sand. It is made on the flat and placed on end for casting. The valve-box end, being the part where the explosions take place when the engine is at work, must be perfectly sound; therefore, that end is cast down. To the other end, which is quite plain and easily extended, a rising head is attached to collect the dirt, etc. A full pattern is used for the outside, and the centre or body core is struck up on a barrel in loam. The jacket core is made in two half-boxes, which will be described later.

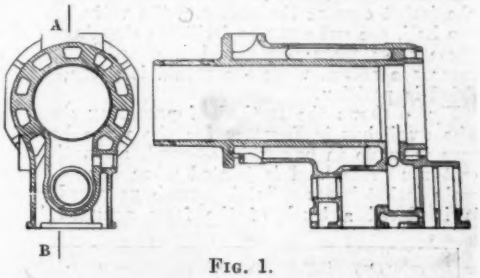


Fig. 1.

The pattern is jointed along the centre line A B. At the plain end a core print C (Fig. 2) of the same diameter as the body core is provided, whereas at the other end the core print D is of the same diameter as the jacket core which is carried through the end of the casting, and requires a bearing. To provide a bearing for the body core at this end, the internal diameter of the jacket core and the external diameter of the body core are made to correspond. The point E carries the part of the jacket core which extends round the valve box, the prints F and G being the other places at which the main jacket core has a bearing on the outside.

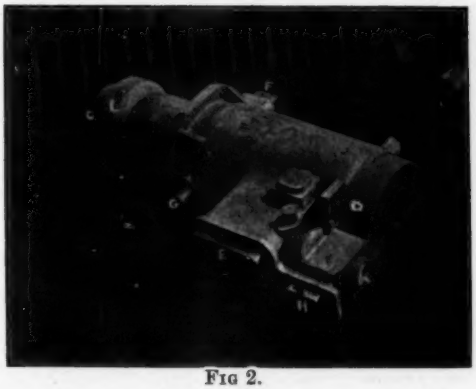


Fig 2.

Prints H K, carry the valve-box cores, the remaining prints being merely for small local cores. The enlarged part L forms the rising head. A definite

method of moulding, coring, and running having been decided upon, the actual moulding is now a very plain and simple matter, requiring no special skill beyond what should be possessed by a good moulder.

The method of running is as follows:—The metal is dropped from the top (Fig. 3), four runners 1¼ in. and ½ in., which are spaced equally round the body core, being used. As this particular cylinder is rather long, a few cwts. of metals are run in at the bottom to form a cushion and prevent the metal cutting the jacket core where it drops. This is done by means of a down runner at the side, which must be provided for in the course of ramming up the bottom part of the mould, and can be seen in the illustration, which shows the finished mould ready for drying. A riser is taken from the flange and another from the head.

Before drying, part of the sand over the prints for the jacket core at the end, and the valve box in the top half, are cut away to facilitate stopping in round these cores when the mould is closed. The small cores are affixed while the mould is green, and are dried in position.

Fig. 4 shows the method of preparing core-boxes. The small box in front is for the valve box. This core is made in halves in oil-sand, strengthened by cast-iron grids, and is jointed when dry. For the main jacket boxes a flat bottom is prepared, and on it is placed a block of the form assumed by the

Fig. 4.

thickness of the metal round the body core and valve box. The box ends are made to follow the thickness of the jacket core required, strickles being made the full length to work on these ends and strickle off the sand to the required shape. At the point where the valve-box joins the body it is necessary to have pieces worked to the required shape, as shown, and used loose. These cores are made in oil-sand, and are strengthened by loose irons, which are easily removed when the casting is being fettled.

The vents in these cores are formed by placing wood-wool bands in the centre of the thickness of sand during ramming (Fig. 5). These all connect with the parts which have a bearing on the outer core-prints. In the course of drying, these bands are more or less charred and form passages for the free escape of gas. After the cores are strickled off to the required thickness, the loose parts of the box are removed and cast-iron plates fixed along each side to support the core whilst being dried. The space between the plates and the rounded part of the core is filled up with floor sand and struck off level. On the top of this is placed the cast-iron plate on which the core is carried for drying, the whole being cramped together and turned over.

After being dried, any variation in the cores is dressed off by rubbing with a piece of emery stone, after which the whole is given a good coat of blacking (Fig. 6). It might here be said that we find it necessary when using oil-sand cores to allow ⅛ in. in 9 in. for sinking. The connections with the vents can be seen on the finished cores.

The remaining core is that of the body. This is struck up in loam on a barrel in the ordinary way,

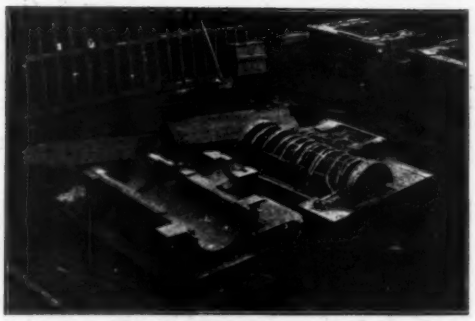


Fig. 5.

except that provision is made for the chills beforementioned, which are placed opposite the two thick parts of metal in order to produce an equal rate of cooling and prevent spongy or drawn places. These chills are made 6 in. wide and 1½. thick in six segments, each of which is ⅛ in. short of a sixth of the diameter required. The spaces between them are filled with loam, and allow for the contraction of the casting, so that the chills are easily removed when the casting is being fettled. The core is made of such a length that it extends about a foot beyond the end of the moulding-box in order to project well above the runner-box when casting.

In assembling (Fig. 7), the first core to be fixed is the bottom half of the main jacket core. This rests on the prints D, E, F, G, but in addition to these, two double studs are placed under the end nearest the flange, as the two side cores are not sufficiently strong to support the weight. When this is fixed, there is a bearing at each end for the body core, which is next placed in position (Fig. 8). This core is inside the moulding-box at the bottom, packings being placed between the barrel and the box-end to support the weight when the mould is placed on end. The space at this end of the core is rammed up

Fig. 6.

with sand, a hole being left through the bottom of the box to take the vent from that end of the jacket core. At the other end a tube is connected with the vent and carried through the side of the box.

The valve-box core is now fixed and the other half of the main jacket core lowered into position (Fig. 9).

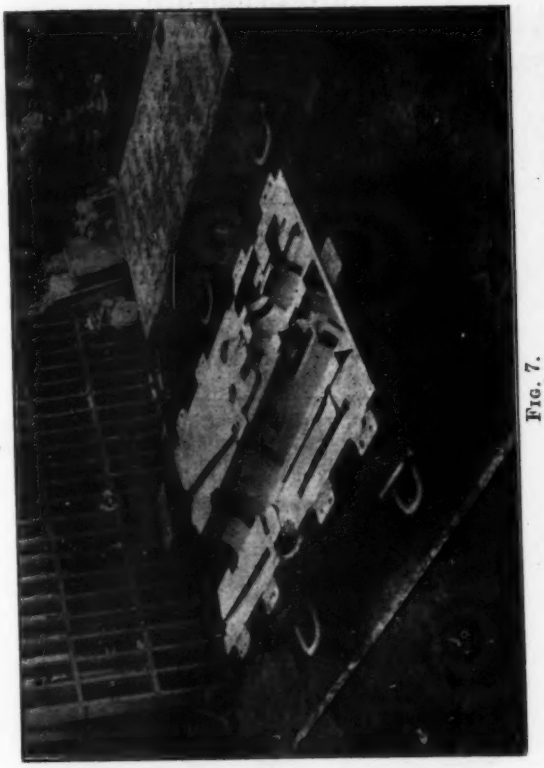


FIG. 7.

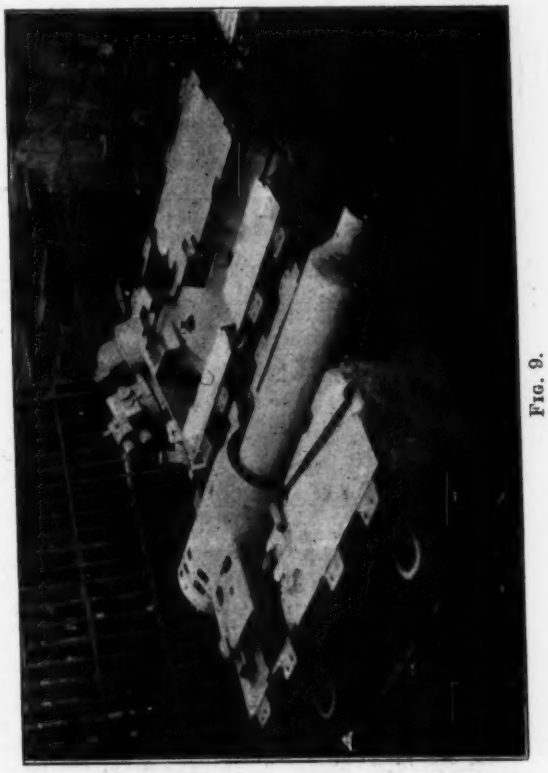


FIG. 9.

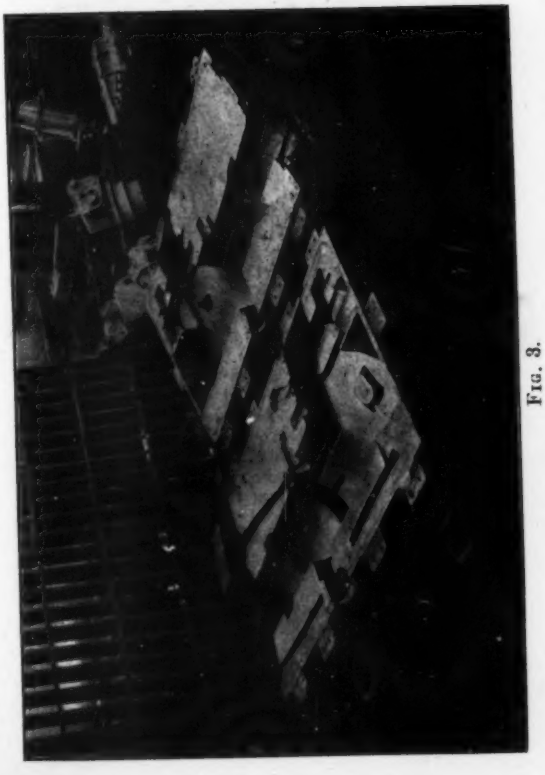


FIG. 3.

FIG. 8.

Pieces of clay to try the space left for metal are placed on the cores and the top part of the mould lowered on. When all thicknesses have been ascertained, studs similar to those mentioned in connection with the bottom part are placed on the jacket core and the mould is closed. The open spaces over the prints before-mentioned are rammed up with sand, the vents being taken off in the same manner as in the bottom part and the whole securely bolted together.

FIG. 10.

The mould is then turned up on end and lowered into a pit for casting (Fig. 10). A large runner box is fixed and a separate box for the riser from the flange. Plugs are placed over the runners and riser round the body core, and a piece of tin over the down runner on the side. When casting commences this tin allows a certain amount of metal to be poured into the runner box before it is melted, and thus prevents any dirt getting down the runner. After a few cwts. have been allowed to run into the bottom and the runner box has been well filled, the plugs over the other runners are drawn off. When the mould is filled the riser plug is removed and the ladle taken to the riser from the flange, metal being poured in there to feed the thick part.

FIG. 11.

As soon as the metal is set the core barrel is withdrawn in order to assist the cooling of the inner walls of the cylinder, which are of a thicker section than the outside. The box is then turned down on the flat, and the bolts through the lugs eased to allow for the expansion of the box, as otherwise there is a danger of the lugs being broken off.

Fig. 11 shows the finished casting ready for the machine shop.

THIS year is the bicentenary of Thomas Newcomen's steam engine, as well as the centenary of Robert Bell's steamship, the "Comet." It is now proposed to build a memorial to Newcomen at his native town of Dartmouth. Newcomen's achievement was represented by the engine set to work at Dudley in 1712.

Correspondence.

Should Iron be Poured Hot or Cold?

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Regarding this question, dealt with in your admirable editorial note in the August issue, I do not wish to assume any authority, but my own experience, which is neither narrow nor brief, would lead me to answer somewhat as:—"Yes—no; but it all depends." Now, sir, obviously such brevity is not worth much; but I would point out that it is important to know, within limits, the temperature of what is termed "hot iron"; also, the temperature of what is termed "dull iron." When these points are definitely decided, we may fix upon a medium temperature which would possibly be the best solution (all things considered) for a pouring temperature for most kinds of castings. Also, we should first know approximately to what temperature it is possible to heat iron in a properly-controlled cupola. But when such knowledge is obtained, each piece of work will still have its own special conditions to be considered.

Mr. J. Keep says "molten iron should be poured as cold as can be and fill the mould, especially in large castings, to allow of as little decrease as possible." I agree with such advice for large, thick, unimportant castings, but otherwise I use my own judgment. It is possible to have, comparatively speaking, a hot iron which is still sluggish. It is also possible to have a cool yet fluid and quick-running iron. The difference will largely depend upon the amount of carbon, silicon and phosphorus present.

Again, an iron that is very low in the metalloids is not easy to melt to a high temperature, say, to "bright whiteness" which would approximate to 1,450 deg. C., and remain in that state very long. Consequently, when using special pure iron, say in five-ton castings, the quicker it can be handled from the cupola to the mould and poured the better. On the other hand, a metal that is fairly rich in the metalloids, say with Carbon 4 per cent., Silicon 3 per cent., Phosphorus 1.50 per cent., is not difficult to melt to a boiling whiteness and keep in that state for a considerable time. There would be nothing gained from any point of view in rushing that quality of iron in such a state into a mould of any kind, unless it was a very thin casting of the hollow-ware kind, where the only requirement is that the mould shall be run full. It would, as a rule, be a distinct advantage to the casting to allow such metal to cool down a little before pouring; by so doing it would give the bulk of the absorbed gases a chance to escape, and these gases would be considerable in iron of very high temperature. With thick castings, I do not think it matters, so far as concerns the formation of eutectics and the separation of graphite segregations, etc., whether the castings are poured at a very high temperature (say, 1,450 deg. C.) or a very low temperature (say, 1,300 deg. C.), because these formations take place through the range of decreasing temperatures within and below these limits. I think that often what is hot iron to one man is dull iron to another, and *vice-versa*.

Even with refractory material to withstand high temperatures, we should have to differentiate between what should be cast with hot metal, and very hot metal. I do not at any time encourage pouring moulds with dull, sluggish metal.

Yours, etc.,

SIDNEY G. SMITH.

Chesterfield.

Effective Industrial Education of the Foundry Apprentice.

By J. W. Horne, B.Sc. (Edin.), Assoc. Inst. C.E.

In the days when trade guilds were in existence (11th to the 16th century), the term "apprenticeship" signified not only practical training in a particular trade, but also training of character and intelligence, without which it is impossible to become a really efficient craftsman. In those days, during the period of apprenticeship a youth received such an education as trained him how to live, while at the same time fitting him to become an intelligent workman capable of earning sufficient to provide for the necessities of life. It is not the purpose of this Paper to trace the changes which have taken place in the intervening centuries. Anyone who is interested in the subject

J. W. Horne, B.Sc. (Edin.), Assoc. Inst. C.E.

will find considerable food for reflection in the contents of a book on the subject by Reginald A. Bray. He defines an apprenticeship system worthy of the name as having to satisfy three conditions:—

"(i) Adequate supervision for boys up to 18 years; supervision must take into account conduct and physical development.

"(ii) Must offer opportunities of training both general and special; that is, the training of the citizen, and the training of the workman.

"(iii) Provision of a suitable opening on completion of apprenticeship."

This system is ideal, and if ever considered is bound to lead to considerable controversy, but no one will deny that every effort should be put forward. No system of industrial education of the apprentice can be effective unless it gives him the capacity for becoming an intelligent workman, a healthy citizen and a good neighbour. The main purpose of this Paper is to awaken an interest in the training of foundry apprentices in this country, and to give in concentrated form some account of how the question is being tackled in other countries from which information can be obtained; to open up the whole question by discussion and to afford the Members an opportunity of giving a definite lead to the Council of this Association as to what action should be taken in order that foundry apprentices may receive an industrial education fitting them to become not only intelligent moulders but also healthy citizens of the Empire.

The problem of the more efficient education of the engineering mechanic has during late years had the serious consideration of many industrial firms, with the result that considerable progress has been made. But so far as information can be obtained, no great development has taken place in improving the educational standard attained by the foundry apprentice, though the problem has not been neglected by foundry employers. Perhaps the main reason why development in their case is, and has been, so slow, is associated with the fact that as a trade moulding is generally held in low estimation. Though not the most mechanical of the trades, it must be remembered that a mould, to give a sound casting, requires more than the mere force necessary to ram the sand. There are a hundred and one things the moulder must know and consider. Moulders may have themselves to blame for this condition of affairs; in the first place, because there is only an inconsiderable number of them who have done, or are doing anything to increase the esteem in which the public hold the trade, by increasing their respect for themselves; while in the second place, practically comparatively few moulders put themselves about to study the underlying principles involved in the moulders' art, or do anything to raise its status in the mechanical world. There can be no question that foundry work requires a considerable display of mechanical ability as well as a sound knowledge of the physical properties and composition of materials used. Whereas to-day in most industries machinery is taking the place of mechanical skill of the individual, this cannot be said of the foundry, as no great advance has been made in dispensing with hand moulding. Great mechanical ability is required to make a man a reliable and good moulder. To prove this to the world should be the aim of every moulder, commanding thereby increased respect for his trade. One effect of the low estimation in which the trade is held by other tradesmen and engineers in general has always been evident in the poor supply of apprentices with a standard of intelligence equal to that of those entering other trades, especially engineering. While the age of the apprentice entering as a fitter or turner has been raised almost generally to 16, with a resulting advantage, the starting age for the foundry is 14. This means that the boy starts handicapped with a less developed intelligence and at an age when factory life will have a greater deteriorating effect. No doubt much can be done by inducing these foundry boys to attend evening continuation classes; though the good derived from them can but be limited after a strenuous day in the shop. Perhaps there is no department in an engineering works in which apprentices can be kept so constantly employed.

The conclusions to be drawn from the above, with regard to lack of progress in intelligent and industrial education among foundry apprentices, is that it is due to the early age at which they leave school to enter an apprenticeship. Strenuous shop work and want of sufficiently developed intelligence at school prevents real progress at continuation classes. The first important duty, then, which would appear to devolve upon the Council and Members of this Association is to consider how best to raise the standard of the trade in the eyes of the public, so that the apprentices entering the foundry may be, as regards intelligence, equal to, if not better than those entering other trades.

In Germany great attention has been and is being paid to the industrial education of the foundry apprentice. Generally, the scheme follows on the lines laid down at the beginning of the Paper. In its industrial life it is recognised that one of the most important requisites for the flourishing of an enterprise is a capable staff of workmen, the training of whom is one of the most important tasks of a manufacturing establishment, while at the same time it renders a social service to the country. Many of the large employers maintain apprentice schools within the factory, schools which are of an intellectual and not of a manual character. Apprentices therefore obtain a training in manual dexterity and skill under strictly apprenticeship conditions, along with intellectual work closely related to the shop work. The advantages of an employers' apprentice school are the saving of time going to and from school and the releasing of employers from the duty of supervising apprentices outside of shop hours. For those apprentices whose employers are unable to run an apprentice school, facilities on the same lines are provided by the municipalities. Ludwig, Loewe & Company, of Berlin, were the pioneers in the formation of an apprentice school some 10 years ago. A short account of their scheme will be of considerable value and interest.

The Ludwig, Loewe and Company Apprenticeship System.

Apprenticeship extends over a period of four years.

Practical Work.

MOULDERS.

Sand cores, nine months.
Loam cores, six months.
Sand moulding, twelve months.
Carpentry, three months.
Large sand moulding, seventeen months.
Testing and trimming, one month.

LOAM MOULDERS

Loam cores, six months.
Carpentry, two months.
Small loam moulding, twelve months.
Large loam moulding, twenty-seven months.
Testing and trimming, one month.

School Work.

Two afternoons a week—one from two to six and the other from four to six, extending over the whole period of four years.

First Year.—General intelligence, two hours:—The legal relations of the employers and employés; the rights and duties of working men; the history of Trade Guilds; the relationship of apprentices to the Guilds; accident and sickness insurances; Patent and Trade-mark law; citizenship; reading and correspondence. Drawing, two hours. (Instruction in this subject is specialised for foundry work.) Arithmetic. etc., two hours.

Second Year.—Workshop, two hours:—Construction of a foundry; general arrangement; descriptions of the cupola, machines, etc.; lighting and heating; safety appliances; rules for the prevention of accident; hygiene; comradeship; courtesy; order and peace; payment of, and claim for, wages. Drawing, two hours. (Model drawing specially related to foundry work.) Arithmetic, two hours:—Exercises in lighting and heating; transport of raw materials; costing.

Third Year.—Raw materials, two hours:—Materials of construction; their production, classes, and properties; forging and rolling, etc.; properties and manufacture of copper, tin, zinc, etc., and their alloys. Arithmetic and geometry, two hours. Drawing, two hours (model, and with special reference to the foundry).

Fourth Year.—Foundry Education:—Description of the various foundry tools; moulding; casting; cupola practice, etc. Citizenship, one hour:—Constitution of the State and Empire; Imperial revenues and expenditures; the rights and duties of citizens, etc. Drawing, two hours. (Special reference to foundry work.)

This short excerpt from the syllabus indicates that, while a considerable part of the time is occupied with work directly connected with the practical side of the foundry, the most important side of the education is the development of the true idea of citizenship and general intelligence.

American Movement.

The American Foundrymen's Association, a number of years ago, appointed a committee to handle the question of industrial education. The chairman of this Committee is Mr. P. Kreutzpointner, with whom this movement is an earnest lifework. He reports that the National Government must come to the relief of the industries in the matter of industrial schools, since it is seen more and more that the industrial education of all the workers—and not only a few of the best ones—has become a necessity to preserve the industrial standing of the nation. The States of New York and Massachusetts have made a beginning—mention in the case of Cincinnati will be made later.

To make any plan of industrial education effective there must be earnest good-will and co-operation of educators, the manufacturers and business men, and the workmen themselves through their Trades' Unions. This industrial education must be used not only as a means of imparting mechanical skill, but also to raise the ideals of citizenship and act as a socialising agency.

As an introduction to this Paper, industrial intelligence was defined. It will be advisable here to expand it to the ideals of Mr. Kreuzpointner, who says:—

"The sum and substance of industrial intelligence, which should be one of the most valuable achievements of a broad industrial education, gives a man the power to see beyond the immediate performance of the operation at which he is engaged for the time being, the power to see the relation of his skill and the results of his work to the success or failure of himself and his fellow workmen; the power to see the intimate connection and interdependence between his careful or careless, his intelligent or unintelligent, honest or dishonest action, and his personal welfare, the welfare of those depending upon him and the welfare of the community at large. Industrial intelligence includes some knowledge of materials; ideas of their production and cost; ideas of the organisation of a modern industry; ideas of the nature and extent of the business of the country, and a sense of duty and responsibility, as a mechanic as well as a citizen. An education is of little value when rated only by a purely commercial standard."

Or to quote the words of Mr. Thomas Burt: "I doubt whether the people of England have a sufficiently high conception of what education really means. The general idea of getting on is to make a fortune. That is a poor conception. Would they

be willing to be millionaires if their intellect had to be dwarfed and their souls blighted?"

The foregoing quotation from Mr. Kreuzpointner's report goes to show that the Americans are going on the lines of Ludwig Loewe & Company. In an address to the National Education Association Convention, San Francisco, in 1911, Mr. Kreutzpointner pointed out the aims and tendencies of industrial education in Europe, referring specially to Germany, as the result probably of a visit to Dr. G. Kerschensteiner, superintendent of the Schools of Munich, whose reorganised schools are justly attracting the attention of the industrial and educational world.

Mention has been made regarding the system which has lately been put into operation at the University of Cincinnati for the production of foundrymen. The system is briefly as follows:—

(1) Careful selection of high average quality of raw material by University and shop.

(2) Students work at the University and shop on alternate weeks.

(3) Students grouped in pairs; members alternate with each other in shop and University; both shop and class rooms are thus always manned.

(4) Student does same class of work as a regular apprentice, and under same shop discipline. If expelled from the shop, he ceases to be a student of the University.

(5) The student is paid for his work in the shops.

(6) A shops' schedule is arranged between the University and shop authorities, and in accordance with this, a student is moved forward through the various departments of the shop.

(7) Students' school work is identical in standard with that given in all high-grade engineering schools. The shop instruction and certain laboratory courses, which would be but a duplication, or rather, a poor imitation of the experience the boys are getting in the shop, are omitted.

(8) The course is five years in length.

In the opinion of Mr. Porter, who has charge of this work, the most interesting and valuable feature of this course is the shop co-ordination work which has for its object the taking of the blinders off the boy, helping him to see the real meaning of the operations going on about him in the shops, and giving him an excellent benefit from shop experience; for example, if he has been on the cupola platform, the subject of pig-iron may be taken up, while at another time, the theory of the cupola may be explained, and so on. An effort is also made to introduce the student to the best literature of the foundry. The great value of this feature of the work enables the student to better understand shop methods and processes, but it stimulates his interest in his work and helps to cultivate in him habits of observation. About a dozen of the leading foundries of Cincinnati and vicinity are giving their cordial co-operation to this scheme.

The Foundrymen's Association of France encourage the raising of the standard of foundrymen by offering money prizes for Papers dealing with foundry problems; but no definite information can be obtained to show that the French education authorities or employers are doing anything to systematise the industrial education and production of foundrymen.

It would appear advisable to extend the information incorporated in the foregoing Papers, and a Sub-Committee of the Council of the British Foundrymen's Association could with advantage be appointed to go thoroughly into the whole question of the training of foundry apprentices and develop a scheme suitable for the best interests of the country, industrial and otherwise, to be sent to Government Education Authorities and Authorities of Technical Colleges and Schools.

"F.T.J." Bookshelf.

Boy Labour and Apprenticeship.

By Reginald A. Bray, L.C.C. London: Constable & Company, Limited, Orange Street, Leicester Square.

The author of this work has attacked a problem which threatens to demand very serious treatment during the next few years, viz., the regulation and control of the education and training of the working-class boy from the present age of leaving school until he has developed the capabilities and intelligence necessary for self-dependence. To trace back over the last five centuries the course of child education and training is to admit that the future will not countenance the turning out from the schools of immature intelligences and incapable units by the thousand, as is at present being done. The advances of scientific manufacture and of machine design and application have largely cancelled the demand for untrained operatives and workers with mere physical strength, and instead are demanded workers of a higher mental grade. On every hand the mechanical trades complain of the lack of really well-trained intelligences amongst those who recruit the ranks; and at the same time the casual labour problem increases in its gravity. The author of the book before us traces the causes of some of these phenomena, in an historical survey of the operation of trade guilds, their decline, and the conditions which became associated with the concentration of industry in large centres. He indicates clearly the valuable features of the old apprenticeship system and the cause of its decline, and after a well-reasoned claim for a radical reconsideration of the present system of training, he suggests a scheme to meet the various conflicting factors that have to be faced to-day in dealing with the subject. In brief, this scheme amounts practically to apprenticeship to the State of every boy on leaving school, the regulation, supervision and control of boy labour, and the restriction of employment of boy labour in certain trades. The scheme as presented is plausible, and offers much to commend it, and though it will doubtless meet with much opposition in many quarters, it is well worth the attention of educational reformers. That it runs contrary to many existing prejudices is not sufficient to condemn it as impracticable; for it has as its objective a higher standard of efficiency in the workers in all industries, and this alone should claim for it more than passing attention.

Notes on Foundry Practice.

B. J. J. Morgan, F.I.C., F.C.S. London: Charles Griffin & Company, Limited, Exeter Street, Strand, W.C.

A useful little volume has been added by the author of this book to the minor works on foundry practice. The book occupies only about 100 pages, but summarised the important matter relating to both the practical and the scientific side of the foundry work which is to be found in detail in more extensive works. A number of well-known standard works have been drawn on for the information, which is presented in clear and concise form. As a foundry text-book, of course, it does not rank with McWilliam & Longmuir's "Modern Foundry Practice," and similar works; but nevertheless it should be found very useful for engineering students and others who desire to have the work and requirements presented in a concise form.

The Influence of Sulphur on Cast Iron.

By H. I. Coe, M.Sc. (Birmingham).

Sulphur is one of the five impurities which are invariably present to a greater or less extent in all irons and steels, but unlike the other impurities its percentage is never expressed in units; in fact, more often than not the sulphur content is shown only in the second decimal place. It is seldom that sulphur in pig-iron exceeds 0.3 per cent., and in such cases the iron has generally to undergo some special treatment before it can be applied to its commercial uses.

It may be of interest to consider briefly the reasons for the presence of sulphur in pig-iron. The materials —ore, flux, and fuel—charged into the blast furnace, contain sulphur, in the form of sulphides and sulphates, and from 5 to 10 per cent. of this sulphur enters the metal, the remainder passing into the slag. The higher the temperature of the melting zone, and the more basic the slag, the less sulphur enters the metal. The sulphur in the pig-iron produced exists in combination with iron and manganese in the form of sulphide.

It is important to remember that in the remelting of iron in the cupola a considerable portion of the sulphur in the coke passes into the metal, and this fact should be borne in mind in calculating foundry mixtures. Most authorities are agreed in stating 0.03 per cent. as being the average amount by which the sulphur content is increased by remelting in the cupola, though this figure will vary according to the percentage of silicon and manganese in the iron; the higher the percentage of these elements the less sulphur will be absorbed by the iron, other conditions being similar.

The effect of sulphur on the physical and mechanical properties of cast iron has been discussed by several eminent metallurgists, the first of whom, perhaps, was Dr. Percy, who, in his book on "Iron and Steel," describes experiments performed by Karsten, which indicated that the addition of 0.5 per cent. sulphur to a melted grey iron resulted in the production of a white iron. Further experiments performed in Dr. Percy's laboratory by R. Smith and W. Weston afforded confirmation of Karsten's results; hence, Percy states that "sulphur in certain proportions has the power of causing carbon to remain in the combined state during solidification after fusion."

He refers also to the work of Caron indicating the effect of manganese in eliminating sulphur, especially after a repeated melting, but expresses doubts as to the manner in which the manganese acts, and suggests that the elimination of the sulphur is due to oxidation by the air to sulphur dioxide, which is assisted by the manganese.

Coming to more recent times, most of the information on this subject is due to J. E. Stead and to D. M. Levy, though reference should be made to the works of T. Turner, J. Keep, T. D. West, A. H. Hiorns, and others.

It will be useful to discuss the work of the two first-mentioned investigators.

Dr. Stead,* in an interesting Paper read before the Staffordshire Iron and Steel Institute, brings out several important points relative to sulphur and cast iron. The influence of silicon and manganese in eliminating sulphur from iron is shown, and reference is also made to Saniter's process of desulphurising iron. Some excellent sulphur prints are reproduced, which show the mode of occurrence and the segregation of sulphur in pig-iron.

Again, in his Presidential address to the Chemistry Section of the British Association for the Advancement of Science (see "Nature," 1910, Vol. 84, p. 302), Stead has described some very interesting experiments he performed to obtain an explanation of the influences of sulphur and of silicon on cast iron. By means of analyses he shows that sulphur and silicon may exist in carbide of iron, and in connection with his experiments he makes the following statements: "It is the sulphur that crystallises with the carbide which is mainly responsible in preventing the separation of graphite by making the carbide more stable"; and "It is the instability of these silico-carbides which is mainly responsible for the graphitic character of grey irons rich in silicon and low in sulphur."

Another point of interest is that the addition of one per cent. of manganese, by eliminating the sulphur from the carbide, reduces the combined carbon from 3 per cent. to 0.6 per cent.; again, the micro-photographs reproduced show the separation of iron sulphide, FeS, in the carbide plates.

Levy* in his admirable Carnegie researches has thrown a flood of light on a difficult subject, and has offered an explanation of the phenomena observed, which there is every reason to respect. In passing, these researches are accompanied by exhaustive bibliographies of the subject. The chief points in the summary of his first Paper are as follows:—

In cast iron free from silicon and manganese, sulphur up to 0.8 per cent. exists as FeS, this representing the saturation limit. The sulphide separates in the neighbourhood of 1,130 deg. C., together with, and as a component of, the austenite-cementite eutectic, forming a triple austenite-cementite-sulphide eutectic.

The balling up of the constituents of the eutectic areas at high temperatures resulting in the formation of massive cementite, which appears necessary as a preliminary to the decomposition of cementite, is prevented by the presence of iron sulphide in the eutectic as intervening layers and as sulphide films between the cementite crystals.

The effect of sulphur on the strength of cast iron free from silicon and manganese is not very great, and the sulphur does little more than emphasise the hardness, brittleness, and weakness of the irons. There is no evidence to indicate chemical union with the carbon, but the research shows that the effect of sulphur is a mechanical one.

In an interesting summary dealing with the constitution of cast iron, Levy† states that "sulphide of iron acts mechanically and physically in such a way as to oppose the conditions which favour the decomposition of iron carbide, from which graphite results; physically, by a lowering of melting points and by surface tension, and mechanically, by forming sulphide films and envelopes around the cementite crystals." He indicates also, the probability of these emulsifying envelopes of sulphide acting in opposition

* "Sulphur and Iron." Proceedings of the Staffordshire Iron and Steel Institute, 1907-08, p. 103.

* "Iron, Carbon, and Sulphur." C.S.M. No. II. p. 33, 1908. "A Study of the Manganese Sulphides and Silicates in Iron and Steel." C.S.M. No. III, 1911, p. 260.

† "The Constitution of Cast Irons and Carbon Steels from the Practical Standpoint," Journal Iron and Steel Institute, No. I, 1910, p. 483.

to the expansion which accompanies the formation of graphite from carbide, and so retarding the change.

In later Papers, dealing with the relations of manganese and sulphur in cast iron, he shows that sulphur in the presence of manganese may exist as (1) dark coloured MnS, free from FeS, and most infusible; (2) paler varieties containing up to 50 per cent. FeS in solid solution, more fusible; (3) composite sulphides consisting of MnS. FeS solid solution together with FeS itself. Manganese well in excess of the theoretical proportion was required to ensure the absence of the paler and composite forms. The latter is found to behave like iron sulphide itself in the mode and conditions of its separation from the iron, in its association with the carbide, and its influence on the carbon condition. He points out the distribution and quantity of sulphide found in specially prepared, and in commercial cast-irons.

W. H. Hatfield* has recently published the analysis of the cementite in a cast iron having the following composition :—Carbon, 3.16 per cent.; silicon, 0.97 per cent.; manganese, 0.04 per cent.; sulphur, 0.45 per cent.; phosphorus, 0.05 per cent. He found it to contain 0.49 per cent. silicon, traces of manganese and no sulphur; and he remarks that the silicon content of the cementite is abnormally low, and accurate determinations could be made owing to the comparatively small quantity of metal employed.

Transverse tests were made on 1-in. square bars between 12-in. centres, and tensile tests on round bars $\frac{3}{4}$ in. diameter. The majority of the bars were too hard to be machined, so that in all cases, in order to make the results strictly comparable, the tests were applied to the bars as cast; accurate measurements were made in every instance, and corrections applied to the results registered on the machines. The hardness tests were applied to the transverse bars after the skin had been filed off, and the surface polished smooth by means of emery paper. The instrument used was the Scleroscope, which has been shown to give trustworthy results. Objection may be raised to merely determining the superficial hardness of the bars. The author was forced to the conclusion that in the particular irons prepared, this was the only means of obtaining comparable results, since the hardness of the cross-section varied considerably from edge to edge of the bar. Again, in the case of cast iron, the superficial hardness is of considerable importance. The hardness numbers given represent, to a certain extent, the chilling action of the sand on the different irons. The results of the mechanical tests, together with the analyses of the bars, are given in Table I.

TABLE I.

No.	Transverse strength 12"×1"×1".	Deflection.	Tensile strength	Hardness number.	Total carbon.	Graphitic carbon.	Combined carbon.	Silicon.	Sulphur.	Manganese.	Phosphorus.	Remarks on the sand castings.
	Cwts.	Inches.	Tons, sq. in.		Per cent.	Per cent	Per cent	Per cent	Per cent.	Per cent.	Per cent.	
1..	25.3	0.100	10.06	58	3.04	1.77	1.27	0.80	0.010	0.025	0.01	Edges chilled, grey centre.
2..	—	—	10.46	59	3.06	0.26	2.80	0.80	0.034	0.025	0.01	White fracture, slightly mottled.
3..	35.4	0.114	—	60	3.13	0.33	2.80	0.78	0.060	0.025	0.01	Ditto.
4..	39.6	0.120	10.18	58	3.00	0.33	2.67	0.82	0.103	0.025	0.01	Ditto.
5..	23.5	0.102	9.03	47	3.05	1.95	1.10	1.31	0.011	0.03	0.01	Very slight chill.
6..	32.5	0.116	13.28	50	3.16	1.45	1.71	1.35	0.050	0.03	0.01	Considerable chill.
7..	42.0	0.127	—	56	3.00	0.80	2.20	1.30	0.105	0.03	0.01	White fracture, slightly mottled
8..	35.6	0.122	—	56	2.94	0.50	2.44	1.32	0.150	0.03	0.01	Ditto.
9..	39.9	0.122	13.05	61	2.91	0.40	2.51	1.17	0.193	0.03	0.01	Only centre mottled.
10..	23.8	0.132	10.10	43	3.02	2.10	0.92	1.62	0.015	0.040	0.01	Grey fracture.
11..	24.1	0.118	15.84	43	3.12	2.12	1.00	1.60	0.031	0.040	0.01	Ditto.
12..	30.2	0.120	14.28	43	2.90	1.75	1.05	1.63	0.056	0.040	0.01	Ditto.
13..	30.7	0.126	—	40	3.02	1.80	1.22	1.40	0.084	0.040	0.01	Corners chilled.
14..	28.9	0.127	8.84	43	3.09	1.95	1.14	1.57	0.090	0.040	0.01	Ditto.
15..	26.7	0.096	14.50	49	2.94	1.69	1.25	1.52	0.103	0.040	0.01	Edges chilled.
16..	28.5	0.102	18.48	60	3.05	1.80	1.25	1.69	0.112	0.040	0.01	Ditto.
17..	30.5	0.090	12.24	60	2.87	0.67	2.20	1.55	0.155	0.040	0.01	White, mottled centre.
18..	20.0	0.080	9.92	45	2.73	1.73	1.00	2.24	0.016	0.030	0.01	Grey.
19..	27.9	0.114	13.04	45	2.90	1.84	1.06	2.24	0.104	0.030	0.01	Ditto.
20..	35.7	0.150	19.71*	43	2.70	1.57	1.13	2.37	0.180	0.030	0.01	Ditto.
21..	27.3	0.097	12.61	53	2.90	1.57	1.33	1.23	0.204	0.325	0.01	Edges chilled, grey centre.
22..	29.0	0.125	14.90	44	3.06	2.34	0.72	1.05	0.027	0.857	0.01	Grey fracture.

* Specimen broke in the shoulder. Turned to $\frac{1}{2}$ in. diam., gave 21.2 tons/sq. in, tensile.

deduces that although sulphur is not found in it, it is responsible for the comparative absence of silicon. He indicates, however, the possibility of sulphur existing to a small extent in the carbide.

The author will have occasion further to refer to the work of these investigators in discussing the results of his own experiments.

The base taken in the present research was an American washed iron containing about 3.3 per cent. combined carbon, with only traces of other impurities. In the preparation of the test bars a calculated amount of low-grade ferro-silicon, made by melting a pure high-grade ferro-silicon with washed iron, was melted in a plumbago crucible with washed iron and the requisite amount of iron sulphide and a manganese alloy. It was endeavoured to keep the casting, temperature as constant as possible, though no

It will be observed that the table may be divided into four portions, and that consideration is taken of the effect of sulphur on cast iron containing (*a*) 0.8 per cent. silicon, (*b*) 1.3 per cent. silicon, (*c*) 1.6 per cent. silicon, and (*d*) 2.25 per cent. silicon. In addition, bars 21 and 22 were cast to show the influence of manganese on siliceous irons containing sulphur.

The third group is the most complete, though here, as in the other groups, the sulphur content does not exceed that met with occasionally in foundry practice.

The chemical relations of the bars present points of interest, since they afford definite knowledge of facts which, though familiar, have not been put upon a scientific basis. Briefly, the addition of sulphur causes an increase in the percentage of combined carbon, this effect being the more marked the lower the silicon content. In other words, a higher percentage of sulphur is required to produce a given effect on a cast iron high in silicon than on one low

* "The Chemical Physics involved in the Precipitation of Free Carbon from the Alloys of the Iron-Carbon System." Proceedings of the Royal Society, A. Vol. 85, 1911.

in silicon. A comparison of the compositions of bars 4, 9, 17, and 20 will illustrate this point.

Another point of interest shown best in the group of irons containing 1.6 per cent. silicon, is the presence of a kind of critical point at near 0.1 per cent. sulphur, at which the carbon relations change somewhat suddenly.

Bar 14, containing 0.09 per cent. sulphur, is not markedly different from bar 10, with only 0.015 per cent. of sulphur as regards the relative percentage of graphitic carbon and combined carbon, but so soon as the sulphur exceeds 0.1 per cent. the percentage of combined carbon rapidly increases with a corresponding fall in the amount of graphitic carbon. The percentage of sulphur corresponding to this critical point will vary according to the percentage of silicon present. An examination of the microstructure of the bars, to which reference will be made later, affords ample confirmation of these facts.

Bar 2 was poured at a low heat, and the mould of the transverse test bar was not properly filled, the low casting temperature is responsible, the author believes, for the apparently abnormal percentage of combined carbon.

The mechanical tests are likewise interesting; both the transverse strength and the tenacity are considerably increased by the addition of sulphur. The most striking results were those obtained from bars 18, 19, and 20, containing over 2 per cent. silicon, which show that quite a considerable amount of sulphur may be added to a rich silicon iron without hardening it appreciably, and at the same time greatly increasing its strength. The author wishes to state here that during the pursuit of the present research, he has met no evidence in support of the

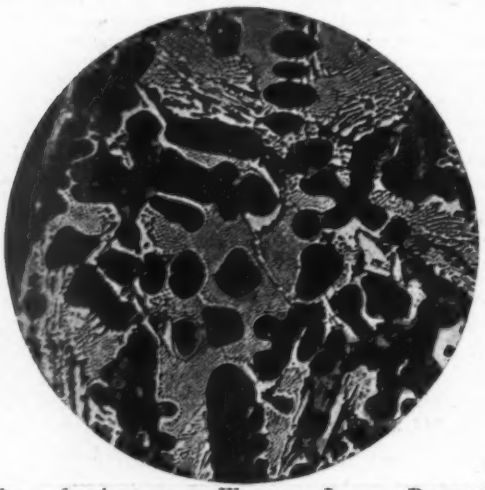


FIG. 1.—AMERICAN WASHED IRON. PEARLITE EMBEDDED IN EUTECTIC OF PEARLITE AND CEMENTITE. MAG., 125 DIAMS.

FIG. 2 (BAR 10).—GREY IRON, 1.62 PER CENT. SILICON; 0.015 PER CENT. SULPHUR. PEARLITE (LIGHT) EMBEDDED IN EUTECTIC OF PEARLITE AND GRAPHITE. A FEW WHITE POOLS OF CEMENTITE. MAG., 125 DIAMS.

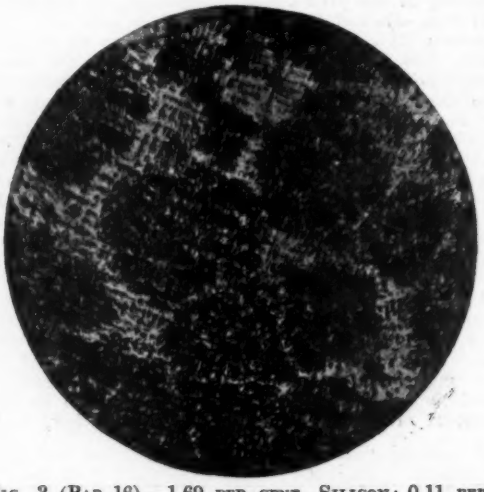


FIG. 3 (BAR 16).—1.69 PER CENT. SILICON; 0.11 PER CENT. SULPHUR. GREY PORTIONS SURROUNDED BY PEARLITE-CEMENTITE EUTECTIC. MAG., 45 DIAMS.

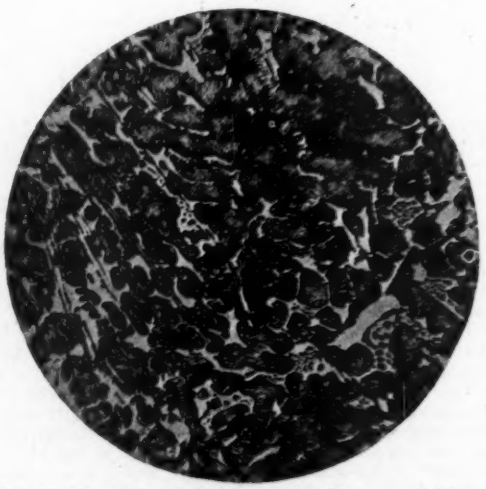


FIG. 4 (BAR 17).—1.55 PER CENT. SILICON; 0.15 PER CENT. SULPHUR. MAG., 125 DIAMS.

opinion generally held that sulphur increases the brittleness of cast iron; on the contrary, sulphur to the extent included in his experiments, appears to increase the resistance of the metal to fracture very considerably. For instance, when pieces were required for the preparation of microscope specimens, those bars which were too hard to saw required quite severe hammering before chips were broken off. Another point worthy of notice was the comparative absence of blowholes; only in bar 20 were a few small blowholes observed, while near the top of bar 22 a serious "draw" was observed containing a number of bright globular inclusions, which were thought to be globules of manganese sulphide, but which proved on analysis to be extruded portions of eutectic containing 3.93 per cent. carbon and 0.055 per cent. sulphur. Perfect eutectic structure of both the grey and the white variety was seen when these globules were

FIG. 5 (BAR 17).—HEAT-TINTED; FeS APPEARS BLACK, THE PEARLITE LIGHT, AND THE CEMENTITE IN HALF-TONE. MAG., 200 DIAMS.

examined under the microscope, Fig. 7. Shrinkage and chill were not determined directly, but a good indication of their probable values can be obtained by a study of the carbon conditions.

The Microstructure of the Bars.

The microstructure, in addition to bearing out the change in the condition of the carbon as shown by analysis, indicates the condition in which the sulphur exists and its distribution in the metal.

The unetched specimens showed the sulphur to exist as yellow-brown blobs and lenticles of sulphide of iron, FeS. Etching in picric acid was not quite successful in throwing up the FeS in relation to the surrounding constituents, and it was found that the best method of treatment was to heat tint the polished specimen to a yellow-brown colour; the cementite assumed a pink-red tint, the pearlite showed brown, and the FeS became coloured a bright blue. Unfortunately, although for visual examination the method is excellent, the particular colours obtained did not yield satisfactory contrasts on the photographic plate.

The irons containing 1.6 per cent. silicon, and varying amounts of sulphur were examined the most carefully, since they present the most complete gradation in compositions and properties. Bar 10 (Fig. 2), which contained only a trace of sulphur, showed the typical microstructure of a pure siliceous grey iron, consisting of dendrites of pearlite embedded in an eutectic of graphite and pearlite, and containing a few pools of cementite.

The addition of sulphur up to 0.09 per cent. tends to destroy the marked dentritic structure, and yields a finer graphite; further addition of sulphur causes the retention of a rapidly increasing proportion of carbon in the combined form. Fig. 3, bar 16, at a low magnification, illustrates this tendency, and is interesting since it throws light upon the solidification sequence in such cast irons. It will be observed that grey patches (pearlite and graphite) have first solidified, and that the pearlite, iron carbide eutectic has solidified around these masses.

The FeS in the grey irons of the series was found towards the boundaries of the primary crystals, but in very few cases was it found near the flakes of graphite; in these irons the few isolated pools of

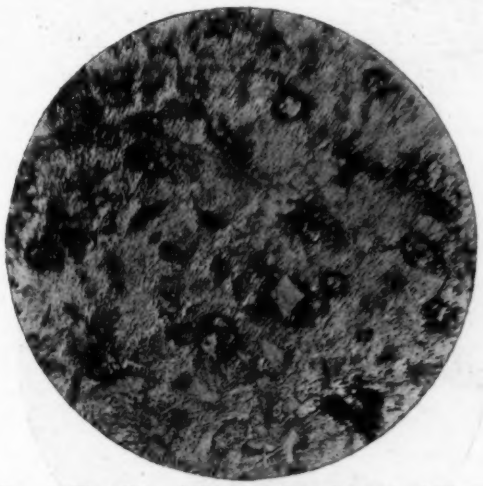


FIG. 6 (BAR 21).—1.25 PER CENT. SILICON; 0.33 PER CENT. MANGANESE; 0.204 PER CENT. SULPHUR. SHOWS CUBIC CRYSTALS OF MnS. MAG., 350 DIAMS.

cementite appeared to act as centres for the collection of a number of blobs of FeS.

In the mottled irons by far the greater portion of the FeS was observed in association with the pearlite, iron carbide eutectic, and comparatively little is seen in the grey fields. The manner in which the FeS is associated with the eutectic is interesting in view of evidence put forward by Levy. It appeared for the most part fairly intimately associated with the eutectic, and may form the third component of a triple eutectic. It was observed, however, that the degree of association appeared less in the case of those irons high in silicon than in those low in silicon.

Before attempting to explain these observations it may be well to refer once more to the fact that iron carbide has been shown to possess the property of retaining a considerable amount of silicon in solid solution, and also a small quantity of sulphur. Further, that the presence of sulphur in the iron diminishes considerably the quantity of silicon found dissolved in the iron carbide. Lastly, the effect of emulsifying films acting physically and mechanically in preventing the decomposition of iron carbide, which, it is generally acknowledged, separates out prior to the formation of graphite.

The sequence of solidification in a pure iron-carbon alloy containing about 3 per cent. carbon will easily be followed by those familiar with the iron-carbon equilibrium diagram.

The fluid metal when cooled will commence to solidify in the neighbourhood of 1,290 deg. C., and solidification will proceed progressively with fall in temperature until at 1,132 deg. C., the remaining mother liquor solidifies at a constant temperature. The crystals which separate out first, or primary crystals, consist of a solid solution of carbon in iron (austenite), and break up at a dull-red heat (700 deg. C.) to form pearlite.

The mother liquor, which solidifies at 1,132 deg. C., forms on solidification an eutectic consisting of alternate layers of the solid solution just mentioned, and iron carbide, or cementite, Fe_3C. Fig. 1 shows the theoretical structure of an iron containing 3 per cent. carbon.

Iron carbide decomposes fairly readily into iron and graphite according to the equation $Fe_3C=3Fe+C$. It may be remarked that owing to the diffusion of carbon from the austenite portions into the ferrite formed, such ferrite may not be observed under the microscope.

It is now necessary to consider the effect of the addition of sulphur to such an alloy. The initial point of solidification is slightly lowered, and the sulphur (as FeS) concentrates in the mother liquor until it

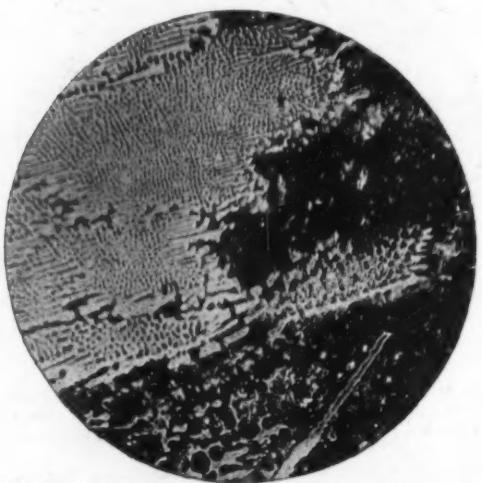


FIG. 7.—INCLUSION IN BLOWHOLE IN BAR 22, SHOWING WHITE AND GREY EUTECTIC STRUCTURE. 3.93 PER CENT. CARBON. MAG., 250 DIAMS.

freezes to form the eutectic. The FeS then solidifies as a third component of the eutectic, and apparently a small quantity remains in the cementite in the state of solid solution. Owing probably both to the mechanical action suggested by Levy, and to the contained sulphur demonstrated by Stead, the cementite decomposes less readily, with the resultant tendency to the production of a white iron.

The addition of silicon instead of sulphur will result in a different mode of solidification. A portion of the silicon separates out dissolved in the austenite, while the remainder concentrates in the mother liquor until when the eutectic solidifies some is found in the austenite portion and some in the carbide portion. That dissolved in the cementite promotes the decomposition of that constituent, hence there is a tendency to the production of a grey iron. It must be borne in mind that when either sulphur or silicon is present, much will depend on the rate of cooling during solidification.

It is now necessary to consider the case when both sulphur and silicon are present. As before, some of the silicon separates in the austenite, the remainder together with all the sulphur concentrating in the mother liquor. Now it has been shown that sulphur and silicon are antagonistic to one another, and a study of the microstructure is instructive in indicating the precise condition of affairs. It appears that if the sulphur be fairly high it tends to solidify in the very last portions of the eutectic, and most of the silicon crystallises in the first portions of the eutectic, the cementite of which, owing to its freedom from sulphur, decomposes readily.

The last portion of the eutectic to solidify contains the greater part of the sulphur, and so forms a white network around the solidified grey areas. On the other hand, when the silicon is high relatively to the sulphur, the latter as FeS appears to be expelled from the eutectic mother liquor just prior to its solidification.

When manganese is added in just sufficient quantity to combine with the sulphur present in an iron, a dove-grey crystalline sulphide is formed, which, according to Levy, consists probably of a mixture of manganese and iron sulphides. Examination of this constituent under the microscope (Fig. 6) points to its solidification in the spines of earlier formed primary crystals of austenite. When more manganese is added than is required to form MnS with the sulphur according to formula, interesting results are obtained. Bar 22 which should contain 0.2 per cent. sulphur is found to contain very much less than that amount. 0.34 per cent. manganese was lost during melting and pouring, some by oxidation, and some by the escape of manganese sulphide.

Evidently in this melt part of the manganese combined with the sulphur to form manganese sulphide, MnS, which, owing to its high freezing point and very slight solubility in molten cast-iron, would tend to separate out before the formation of the spines of primary crystals, and would thus rise to the top of the fluid before pouring. A small quantity of MnS is retained in the solid metal, owing probably to a slight solubility in the mother liquor after solidification has commenced. The effect of manganese in neutralising the powerful influence of sulphur on the condition of the carbon is well illustrated in Table I. The abnormally low combined carbon content of Bar 22 is due to the excess of manganese over that required to form MnS with the sulphur. (*Vide* Paper by the author to this Association, January, 1911).

The practical application in the iron foundry of the results obtained from this research is worthy of a short discussion. It must be clearly borne in mind that these experiments were performed with the purest materials obtainable, and similar results would not be obtained with the use of commercial irons. The almost complete absence of phosphorus is a point to be mentioned; again, except in two bars, manganese is practically absent.

In spite of these facts, the author believes some useful information may be obtained from a study of Table I., the main features of which are summarised as follows:—

(*a*) The sulphur, in the absence of manganese, separates as sulphide of iron, FeS, either with, or immediately before the eutectic, according to the percentage of silicon.

(*b*) The influence of sulphur on the condition of the carbon varies according to the percentage of silicon present; when the silicon is low (about 1 per cent.), very small additions of sulphur will throw the greater part of the carbon into the combined form; when the silicon is high, the effect of sulphur is very much less marked.

(*c*) A critical point, as regards the percentage of sulphur, appears to exist, at which the effect of the sulphur changes comparatively suddenly. The

position of this critical point will change according to the silicon content.

(*d*) The influence of sulphur on the mechanical properties is due chiefly to its effect on the condition of the carbon, but partly to its modifying the dendritic character of the pure siliceous irons. The transverse strength, tenacity, and hardness are increased by the addition of sulphur.

(*e*) Manganese in sufficient quantity neutralises the influence of sulphur on the condition of the carbon, and in excess it tends to the elimination of sulphur owing to the separation of MnS from the fluid cast-iron before solidification commences.

The ironfounder should, therefore, carefully control the sulphur in those charges where the silicon and manganese are low, or there will be a danger of the casting being white and too hard to machine.

In irons high in silicon, sulphur is far less dangerous, and for strong castings an excess of FeS is advantageous, provided it be not allowed to get so high as to make the castings too hard.

The softest castings will be those containing a minimum of phosphorus consistent with the correct degree of fluidity, silicon about 2.5 per cent., manganese 0.5 per cent. in excess of that required to combine with the sulphur, and a high carbon content.

The Elimination of Sulphur from Cast Iron.

Should it be desired to use a large quantity of white scrap in the cupola charge, it may be necessary to reduce the sulphur content in order that a casting of suitable working qualities may result. This is occasionally done by the addition of ferro-manganese to the metal in the ladle. Desulphurisation would, however, be performed better by using a manganiferous pig-iron as part of the charge. An interesting process, which effects a considerable reduction in the sulphur is that introduced by Saniter.* The desulphurising agent is lime, which is dissolved in calcium chloride and then brought into molecular contact with the fluid iron. The lime, owing to its great affinity for sulphur, combines with that element to form calcium sulphide, CaS, which rises to the surface of the metal. Twenty-five pounds of lime ground with the same weight of calcium chloride are sufficient considerably to reduce the sulphur in a fluid iron. The mixture should be compacted by fusion or other means at the bottom of a ladle and the molten iron poured on; the chloride melts, dissolves the lime, which then combines with the sulphur as it rises through the metal.

Calcium silicide, again, has been used successfully as a desulphurising agent.

Sulphur and Malleable Cast-Iron.

The iron used for the production of the ordinary or Réaumer malleable cast-iron may contain from 0.2 per cent. to 0.4 per cent. sulphur, which serves a useful purpose in yielding castings possessing a white fracture. Since the annealing is an oxidising one, the stability of the carbide as regards its decomposition into iron and graphite is of little importance.

The changes which take place in the production of Blackheart castings are different from those in the Réaumer process, and depend essentially upon the decomposition of iron carbide according to the equation $Fe_3C = 3Fe + C$. But sulphur acts in the direction of opposing this decomposition, and so it is found both in theory and in practice that sulphur above about 0.05 per cent. is fatal to the production of blackheart castings.

In conclusion, the author wishes to express his indebtedness to Mr. A. H. Hiorns, Head of the Department of Metallurgy in the Municipal Technical School, Birmingham, for his kindness in giving him every facility for the conduct of this research.

* "Journal Iron and Steel Institute, 1893." No. I, p. 37.

Annual Meeting of Halifax Foundrymen.

The members of the Halifax Branch of the British Foundrymen's Association recently held their first annual general meeting, which was very well attended. The President, Mr. Hugh Campbell, was in the chair, and was supported by Mr. W. S. Milligan (Sowerby Bridge), Mr. H. O. Arnold (Leeds), and Mr. Robert Buchanan (Birmingham).

In submitting his report of the session's work, the Branch-Secretary stated that the inaugural meeting of the Branch was held in October last year, since which time 103 members had been enrolled, as follows:—10 full members, 23 associate members, and 70 associates. This, added to the 8 full members, 21 associate members, and 2 associates transferred from the parent body made a total membership of the Branch of 134. Subscriptions from members to date were £23 11s., and the total expenses of the Branch since its formation £11 12s. 10d.

During the session seven lectures had been given on technical and advanced ironfoundry practice. These had been well appreciated, the average attendance being over 70, and the discussions in connection with the lectures had called forth a lively exchange of ideas beneficial to all concerned.

The social element had also been touched upon in the shape of a dinner and smoking concert, which was attended, amongst others, by the Deputy-Speaker of the House of Commons, the Right Hon. J. H. Whitley, M.P., who gave a very stirring speech on past and present foundry matters. Altogether the work of the Branch had been very successful.

The officers elected for the next session were as follows:—President, Mr. Hugh Campbell; Vice-Presidents, Mr. W. S. Milligan and Mr. J. Morley; Committee, Messrs. W. Smith, W. E. Noon, F. Limb, A. Midgley, A. Love, F. Berry, J. Siddal, J. Gaunt, A. Edwards, R. Pickles, A. Mason, and A. Brearley; Hon. Sec., J. G. Robinson.

Mr. Campbell, in accepting the office of President, said he would have been pleased to see some other gentleman elected, and was sorry that more employers had not come forward to assist the movement, but he hoped they would do so during the next session. He would personally do all he could to keep the Association alive, and trusted the next session would be even more successful than the last.

A vote of thanks was passed to the retiring officers and also to the Principal of the Halifax Technical College (Mr. J. Crowther, B.Sc.), for the free use of the lecture room during the past session.

Conveying and Hoisting Appliances in Iron Foundries.

Discussing this subject recently before the German Foundrymen's Association, Herr Hubert Herrmanns claimed that the cupola house should be provided with a travelling inclined hoist, and the main shop with a travelling crane of high capacity, supplemented by several bracket cranes along the one side. In the lateral bay or moulding shop should be arranged a small travelling crane, with a crab and pig breaker running along a stationary track over the stockyard alongside the building. The equipment is completed by magnet cranes for transporting the pig-iron, self-acting grabs for the coke, and a mechanical plant for conveying and preparing the moulding sand.

Converter Steel.*

The Tropenas system of producing converter steel is specially adapted for making steel of high quality, such as is used in the motor-car industry, for gas engines, hot-steam valves, turbine parts, etc. The plant now to be described has a producing capacity of up to 40 tons weekly, the converter taking a charge of 2 tons. Of course, the usual foundry appliances, such as electric travelling cranes, mould boxes, drying ovens, etc., must be provided in addition to the converter, motor and cupola furnace, and a chemical laboratory is an indispensable feature.

The arrangement of the converter with relation to the cupola furnace is sketched in Fig. 1, the hot metal being run from the cupola furnace into a casting ladle, and lifted by a swing crane. The luffing and travelling movements of the crane and the tipping of the ladle are effected by hand, three men being required for this stage of the operations. The converter casing —5 ft. in diameter—is of $\frac{3}{8}$rds. in. steel plates, secured by 4-5th. in. rivets spaced about 8 in. apart, so as to allow of the escape of the gases liberated during the process of drying the converter lining. The converter shed is about 17 ft. square and 20 ft. high, to

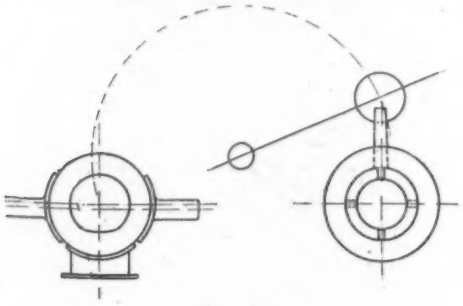


Fig. 1

enable the whole of the flame issuing from the spout to be critically examined throughout the blow. The converter trunnions—one of which is hollowed for the passage of the blast air—are mounted on a trestle; and the converter itself can be tilted front or rear by hand-operated worm gearing or by a 4-h.p. motor. The blow can be continued during the tilting movements. The wind chest is duplicated, the upper compartment being adapted to be shut off separately. A bricked ashpit being provided under the converter; the latter can be turned right round, to facilitate emptying it completely. The covers of the blast chambers are secured by means of keys, to facilitate rapid detachment for cleaning out the tuyeres. Fig. 2 shows a plan and section of the converter, in connection with which the slanting arrangement of the tuyeres toward the surface of the metal should be noted. The blower is of the water-cooled, rotary, high-pressure type, coupled direct to a 75-h.p. motor, and must furnish blast at a pressure of 10 ft. water-gauge (8¾ in. mercury gauge), even when all the tuyeres are run under full blast, *i.e.*, seven lower 1¼ in. tuyeres, and seven upper 1¼ by $\frac{3}{8}$rds in. ones. The blast main leading to the converter is 12 in. in diameter, and should be short and as free from bends as possible, though the length should not be unduly restricted, the pipe acting as a reservoir and giving a certain elasticity to the blast. Blowers of the piston type do not answer well.

For the smelter, who has to watch the blow closely and tilt the converter when necessary, a special platform is provided about 20 ft. to one side of the converter and equipped with the controller for tilting the converter, signalling whistle to let the engineer know when to start and stop the blower, and a mercury pressure gauge. The blower is run at full speed all through the blow, the volume of the blast being regulated by the smelter by means of a valve enabling part of the blast to be discharged into the air.

The cupola furnace is expected to turn out about five tons of very hot molten metal per hour (about half the charge in many cases consisting of steel scrap), and to be able to run for eight to nine hours at a stretch. The molten iron is required to be very low in phosphorus and as free as possible from sulphur. A point to be settled beforehand is whether

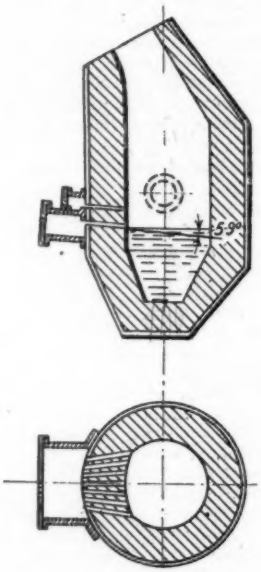


Fig. 2.

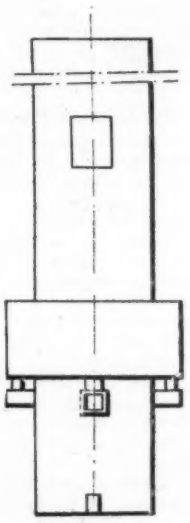


Fig. 3.

the converter charge is to be drawn in one or two stages, since this decision influences the distance at which the tuyeres must be arranged above the bottom, and also the charge of heating coke. The furnace measures about 3 ft. across inside, the lining being about nine inches thick on each side. The slag tap-hole is about six inches below the tuyeres, which are inclined downward at a sharp angle. The working pressure of the blast is about 12 to 14 inches water-gauge. Fig. 3 shows a view of the furnace. The charging platform must be situated at a higher level than is usual in iron foundries, the distance between the floor and the charging door being not less than 13 ft. The platform must be large enough to accommodate all the material to be smelted during a day's work; it must be roomy, well ventilated, and strong enough to carry at least 2¼ tons per sq. yard. The hoist, preferably operated by electricity, must be capable of lifting three tons at a speed of 60 ft. per minute. A Roots'-blower is preferable to the blast.

The ladles are similar to those used in iron foundries, but somewhat deeper, to check the loss of heat, and are constructed with tilting device and spur wheels. Before use, all the ladles must be made red-hot by the aid of oil fuel.

* Translated from an article by J. Holicky in "Giesserei Zeitung."

Great care must be bestowed on the converter lining, which may consist of special bricks, fitting the interior exactly, or more cheaply of rammed sand, the former being preferable, as facilitating the execution of repairs. The usual method, however, is to line it with standard bricks, measuring 9 by 4½ by 2½ inches, either wedge-shaped or arched. In any case the material must be fireproof in a high degree, acid, and consisting of about 95 per cent. of silica, almost entirely free from lime and magnesia. Three wooden centrings, corresponding to the internal shape of the converter, are set up inside in three different positions when the converter is to be lined. Special care is necessary in laying the bottom row of tuyere bricks, which should preferably be numbered, commencing with 0 for the centre tuyere brick, whilst the pairs on either side of this centre are numbered 1, 1, 2, 2, and 3, 3 respectively, as shown in Fig. 4. The air traverses the tuyeres, not in parallel streams, but divergent, in order to spread uniformly over the metal. The right position of the tuyeres is gauged by iron rods inserted through the opening in the wind chest and the tuyere bricks. The converter bottom is lined with pure silica bricks up to within 16 inches of the lower edge of the bottom row of tuyeres. The mouth is about 14 inches wide. To facilitate the operation of lining, the converter is sometimes provided with a vaulted manhole, which may be opened without disturbing the remainder of the lining. The converters are found to last longer when worked and repaired on alternate days. With careful treatment the tuyeres will last out 150-200 charges. When the repairs are executed on the lines mentioned above, the

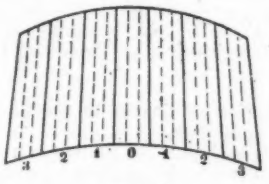


FIG. 4.

tuyeres can be replaced in about three hours. The lining has a working life of about 100 charges before complete renewal. The silica bricks are exposed to considerable wear, since they expand in the heat, crack and fall to pieces. The force of expansion is sometimes so great as to shear off the bolt heads, to prevent which the bolts should be loosened when the converter is lined afresh.

The charge for the cupola furnace consists of pig-iron (75 per cent.) and steel scrap (25 per cent.), produced on the premises. Previous to being blown in the converter, the composition of the molten pig-iron is about: Silicon, 1.80 to 2.10 per cent.; manganese, 0.60 to 1.00 per cent.; carbon, about 3 per cent.; sulphur and phosphorus as little as possible. Limestone or oyster shell is used as flux. The percentage of silicon and manganese in the pig-iron is the chief point to check, since only brands that are very low in phosphorus and sulphur can be used. No. 1 pig contains 3.5 per cent. of silicon and 0.25 per cent. of manganese; No. 2, 2 per cent. of silicon and 1.5 per cent. of manganese; home-made steel scrap averages 0.25 per cent. of silicon and 0.75 per cent. of manganese. On the basis of these data, which must be checked in the laboratory, the weights of the different grades of pig-iron or steel scrap in each charge can be easily determined arithmetically or graphically, so as to obtain metal of the right composition after allowing for losses in smelting.

As an example: assuming that a pig-iron with 2 per cent. of silicon and 0.80 per cent. of manganese is to be produced in the cupola furnace, from Nos. 1 and 2 pig and about 25 per cent. of steel scrap containing 0.25 per cent. of silicon, the two grades of pig will, therefore, form 75 per cent. of the charge. The exact average silicon content in the pig-iron can be determined by multiplying the weight of the steel scrap by the silicon content, and adding the product of the weight of No. 1 and 2 pig and the average silicon content of same, the result being the weight of the charge multiplied by the desired silicon content (smelting losses being left out of consideration). From the above figures we get the equation:

$$250 \times 0.25 + 750 \times X = 2 \times 1{,}000, \quad X = \frac{2{,}000 - 62.5}{750} = 193.75 \div 75 = 2.58.$$

The same result can be found in a few seconds by means of the diagram, Fig. 5. Assuming that a pig iron is desired to contain 2.35 per cent. of silicon previous to remelting, it is found from the diagram that there will be required to furnish this result 75 per cent. of pig with an average of 3.25 per cent. of silicon, when the steel scrap has the silicon content already mentioned.

The proportions of Nos. 1 and 2 pig needed to give the above average are calculated as follows: The weight of No. 1 pig being taken as Y, then the weight of No. 2 pig will be 750 − Y. The sum of the product of the weights and silicon content of each

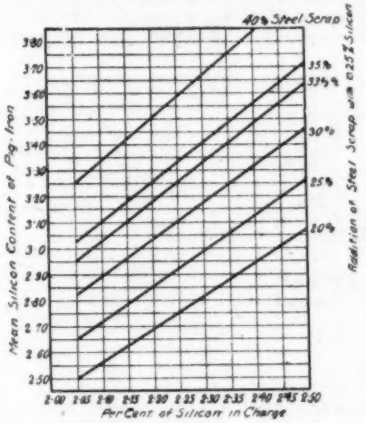


FIG. 5.

will be equal to 750 times the mean silicon content, viz.:—

$$Y \times 3.50 + (750 - Y) \times 2 = 750 \times 2.58.$$
$$1.5Y = 1{,}937.5 - 1{,}500 = 93.75 \div 15 = 290.$$

Consequently the charge will consist of:—

290 parts by weight of No. 1 pig,
760 parts by weight of No. 2 pig,
250 parts by weight of steel scrap.

and must be tested again for its content of silicon and manganese.

The coke used should be of good quality, containing about 0.75 per cent. of sulphur, baked for 72 hours, and used in the proportion of 1 to 7, *i.e.*, about 15 per cent. The molten iron must be superheated and pure. The requisite two tons of this metal may be tapped in one or two operations, the latter being preferable as saving coke for re-heating the furnace, and thus reducing the absorption of sulphur. In the interval the converter is heated up, with a consumption of about 10 cwt. of coke, blast being admitted for two to three hours at a pressure of 28 inches. In order to ensure proper heating of the bottom, the converter is tilted every 15 minutes (the mouth being covered with a plate to prevent the coke falling out), and the tuyere cover is taken off. When the heating is finished, the coke ash is tipped into the ashpit and carefully skimmed hot metal is poured in. The converter is then carefully turned until the surface of the metal is on a level

with the lowest tuyeres, this position being marked on the trunnions. The blast should impinge on the metal at an angle of 5 to 9 deg. If the angle be too large, the metal is stirred up too much, whilst if too small the action is insufficient. When everything is in order, the tuyere cover is put on and the blow is started, the time being accurately noted. At first a brown smoke makes its appearance at the mouth of the converter, with an abundance of sparks, the flame being, however, small. An experienced smelter will know during the first minute whether everything will go on all right. After three to five minutes the sparks cease and are replaced by flame. The upper tuyeres are now opened a little, since the carbon monoxide is commencing to burn, and the converter is tilted 2 to 3 deg. to facilitate the escape of the burned impurities. During the next 4 to 5 minutes the flame becomes larger and brighter, until the boiling stage commences. Should any of the charge be ejected with the flame, the blast pressure is reduced correspondingly. A little slag will be blown out at all times, but this does not matter so long as it does not interfere with the examination of the flame. An impure flame indicates an unsuitable composition of the metal, wrong position of the converter, or too strong a blast. When the flame has reached its maximum for a couple of minutes, it begins to decline for a while, whereupon the upper tuyeres are fully opened, the flame then increasing again

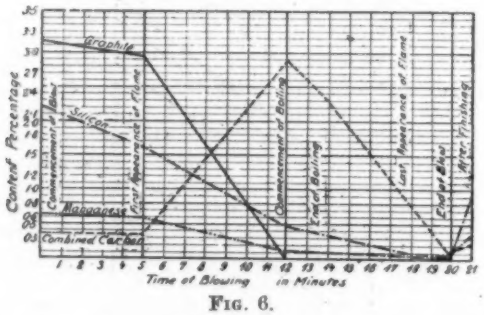


FIG. 6.

and becoming particularly bright and clear, to finally disappear in a cloud of brown smoke. This smoke consists of burned iron, which injures the quality of the metal, to prevent which the converter is tilted a few seconds before this stage is reached, and the blast is stopped. At this moment the converter contains practically pure iron, at a temperature of about 1,650 deg. C., carburisation being then effected in accordance with requirements, after the necessary additions of ferro-manganese, ferro-silicon, and spiegeleisen have been given. These adjuncts are either melted beforehand in a small cupola furnace or crucible furnace, or else they are thrown in in solid lumps. In the latter case they should be dipped in water first, in order that the disengaged steam may burst the hard slag covering the metal. The slag-checking device is now applied, and the metal is tapped into the ladle. The diagram, Fig. 6, shows the changes in the percentages of graphite, silicon, manganese and combined carbon during the blow.

The blow normally takes 15 to 20 minutes, during the first three to five minutes of which the above-mentioned flame should appear. Premature appearance of the flame indicates insufficient silicon in the metal, and necessitates reducing the tilt of the converter to 2 deg. and the addition of 1 cwt. of ferro-silicon. If the flame is longer than five minutes in showing up, either the silicon content is too high or the metal too cold. The high silicon content necessitates a longer blow, with increased waste, and the finished steel will be too high in silicon. If the metal be too cold, all that can be done is to add more silicon, which acts as fuel.

Another drawback is the partial obstruction of the tuyeres by incrustations of slag, which disperse the blast in all directions, causing an increase in the blast pressure and an extensive dispersion of the sparks. These incrustations are due to the metal being too cold, the converter incorrectly tilted, or insufficient removal of slag before commencing the blow. The remedy is to turn the converter over, stop the blast and clean the tuyeres with iron pokers. Sometimes this operation has to be repeated two or three times.

Composition of Steel.

For ordinary machine castings which have to be worked, the carbon content should be 0.25 to 0.3 per cent., silicon 0.25 to 0.3 per cent., manganese 0.6 to 0.75 per cent., with sulphur and phosphorus as low as possible, not exceeding 0.05 per cent.

For harder grades of steel the carbon content should be 0.35 to 0.4 per cent., and if the castings are liable to tear, the carbon must be increased to 0.5 per cent., silicon to 0.3 per cent., and manganese to 1.10 per cent. Such castings must, however, be annealed. For recarburisation and deoxidation, 12 per cent. ferro-silicon, 80 per cent. ferro-manganese or spiegeleisen with 10 per cent. silicon and 20 per cent. of manganese must be added. The weight of the adjuncts can be calculated. For deoxidation an addition of 20 to 30 per cent. is given in the case of ferro-manganese, and about 5 per cent. in the case of ferro-silicon.

For tungsten steel, chrome steel, manganese steel or nickel steel, these alloys must be added after being melted in the electric furnace or by the almuino-thermal process, the later being preferable as giving more concentrated, carbon-free products and thus simplifying matters.

Formation of Cracks in the Castings.

A difficulty still to be overcome is the formation of cracks in the castings. These are of two kinds, one appearing as soon as the metal has solidified, and the other after it has cooled below red heat. The former are generally larger, rough, and coated with a blue to black film of oxide; the cause is either excessive hardness in the moulds or cores presenting undue resistance to the shrinkage of the metal, or else an unduly high proportion of sulphur or copper in the steel. Hot cracks may be prevented by making the corresponding parts of the mould by ramming them up behind with calcined sand, ashes or the like, or else by drying the mould very quickly, so that it loses its stiffness and has only just enough strength to bear the weight of the cast metal. The object to be kept in view is to form the mould of a thin crust of fireproof material backed with a yielding layer, so that the metal finds little resistance in contracting.

The moulds are made of silica sand, rendered plastic with a little fireclay, a hard facing crust being obtained by coating the interior with ground silica and molasses water. The cores are painted over with a mixture of ground silica, Ceylon graphite and molasses water, and dried quickly. If the crust be scraped off, the core should almost crumble away. One or two additional coatings are given and dried, this treatment furnishing a very hard crust only about 1/30th of an inch thick.

To counteract the ill effects of copper and sulphur, the raw material must be selected carefully, since copper cannot be eliminated, and sulphur may be absorbed from the coke. A remedy is afforded by increasing the manganese content, which removes part of the sulphur into the slag as manganese sulphide. The cold cracks are very fine, almost invisible, and can only be detected by very close examination or by the hammer.

A London Steel Foundry.

Castings from the "Stock" Converter.

Until quite recently there was not a steel foundry in operation within the confines of the London County; but this position has now been changed by the erection of a plant at Scrubbs Lane, Willesden, N.W., by the London Steel Castings Company. This plant, though only a small one, is now turning out some excellent work by means of the "Stock" oil-fired converter process. This process, it will be remembered, was described and illustrated in our issue of October last.

Our representative recently inspected the plant at Willesden, and witnessed the operations of charging, melting, blowing and pouring. The converter installed is only a small one, being of 10 cwts. capacity, since the castings being produced are largely motor-car parts and other small pieces. The converter, lined with silica brick, is mounted on trunnions standing on a steel base-plate, which in turn rests on a roller path in a cast-iron base-plate. This provision allows the vessel to be turned round in the horizontal plane.

So soon as the metal is melted the valve controlling the oil supply to the pressure tank is closed, the oil tuyeres are removed from the blast box. and dummies placed over the tuyere holes so that the blast may enter the vessel. The vessel is then turned to the upright position for blowing assumed by the ordinary Bessemer converter, then the refining is carried out by surface blowing at a slight angle to the face of the slag. The blast during blowing is increased to about 3 lbs., the pressure during the heating process being only ¾ lb.

The blowing operation lasts from 20 to 25 minutes, when the vessel is turned down to the charging position and the spiegeleisen and silico-spiegel added, after being melted in a crucible-furnace pot. After this the converter can be revolved to any suitable position for filling the pouring ladles. It may be noted that in the case of slag obstructing the blast tuyeres, the blast can be turned off, the tuyere dummies removed and a rod used to open the tuyere, this taking about two minutes and not affecting the process of refining. Such an operation would, of course, be difficult with an ordinary converter. Before pouring the steel from the converter, aluminium in small quantities is placed in the ladle and the metal then poured. This has the effect of giving greater fluidity, and also preventing blow-holes in the castings.

Results of Experiments to ascertain the Elastic Limit and Ultimate Tensile Strength, etc., of Steel Castings from Stock Converter.

Description. Turned.	Original Dia. Ins.	Area. Sq. in.	Stress. Elastic limit, per square inch. lbs.	Tons.	Ultimate per square inch. lbs.	Tons.	Ratio of elastic to ultimate. Per cent.	Reduction of area. Per cent.	Extension In 2 inches. Per cent.	In 5 inches. Per cent.	Appearance of fracture
2 ins. × 10 ins. long..	0.968	0.736	28,900	12.9	50,150	22.4	57.6	6.6	4.5	4.0	Granular unsound
„ „ ..	0.976	0.748	30,000	13.4	58,300	26.0	51.6	9.4	7.5	6.3	Granular. sound.
„ „ ..	0.977	0.750	30,500	13.6	64,050	28.6	47.6	9.1	8.5	8.0	Granular sound.
Mean	—	—	29,800	13.3	57,500	25.7	52.2	8.4	6.8	6.1	

Blast is supplied by a Root's blower with a capacity of 4 cubic feet per second; direct-driven by an electric motor. The blast enters by a main passage through the centre of the bottom plates—so that the converter may be turned round without interruption—by a vertical blast main outside the converter, and then passes through one of the trunnions to the blast box at the side of the converter. The oil burners, called Jageres, which are removable, are placed within the blast box. In addition to a blower a small pump is employed to maintain a pressure of 40 lbs. in the oil-storage tank, at which pressure it is fed direct from the oil tank into the vessel.

For charging, the vessel is inclined in the horizontal direction, and moved through an angle of 90 degrees. The charging is by means of an ordinary peel, a system which enables the full charge of pig-iron and scrap to be put in by two men in a few minutes. The vessel is then turned in the horizontal position with its nose pointing to the entrance of an economiser. This economiser is an important feature of the plant, serving to recover the waste heat arising from the combustion of the oil during melting. It consists essentially of a series of ribbed cast-iron pipes of U section, through which the blast passes, the heat from the vessel passing round and amongst these pipes on its journey to the chimney. By this arrangement the cold air delivered from the blower is raised to a temperature of about 300 degrees F. before passing to the converter. With the vessel in the horizontal position, the blower is started and the oil lighted. The combination of oil and blast produces a temperature sufficient to melt the charge of iron in about 1½ hours.

At the Willesden foundry a French loam is used for moulding, and gives excellent results. As regards the quality of metal turned out, bending tests were made with several specimens selected at random from a pile of small castings, and in every case the metal bent nearly double before showing any fracture. Tests made on the products by outside authorities are given herewith. It should be noted that the castings were not annealed, it being claimed that the process gives, without annealing, a product of a quality above the average of Bessemer steel castings which have been annealed.

The successful operation of the plant above described upholds the claim that the "Stock" converter, on account of its suitability for small units turning out only a few cwts. of metal a day, opens up a new field for the manufacturer desiring only a small output of this class of foundry work. It appears extremely well adapted for installation as an auxiliary to an iron foundry or an engineering works.

The complete operation of the plant at Willesden was sufficiently rapid to allow four "blows" in one day, since the first heating operation prior to charging is not required if the second charging is done directly the first charge is poured.

Making 60-in. Socket and Spigot Pipes in Loam.

By Sydney G. Smith.

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The following description refers to the making of 60-in. socket and spigot pipes up to 10 ft. long, moulded in loam. There are two ways of making these pipes vertically. One method is in sand, with a pattern; the other in loam without a pattern. In the former method the socket is cast down; in the latter the socket is cast up. The socket will be quite sound cast up, providing the feeding head is of sufficient depth and thickness, and this matter always has attention.

Fig. 1 gives a sectional view of the assembled mould-boxes, tackle, etc., used in moulding such a

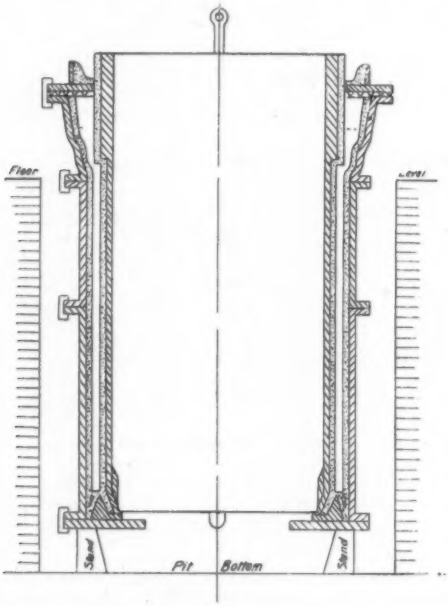

FIG. 1.—SECTIONAL VIEW OF ASSEMBLED MOULD.

casting in loam. A glance at Fig. 2 will show that the brackets that hold the spindle centre plank are bolted on the top flange of the box (D, Fig. 2). These are movable, and when each striking has been done are taken off and replaced when required without any trouble. The bottom plate (Fig. 2) is levelled in the pit so that the total length of boxes when put in place will be about 2 ft. above the floor level. Provision having been previously made for a rail or step for the mould-board spindle, the boxes A, B, C are put onto the bottom plate and cramped together. The core seat is also on the bottom plate and centred. After the top and bottom centres have been plumbed, the mould board and spindle are lowered into position; no more plumbing is needed, unless by any means the boxes are moved, and any number of castings can be made by one fixing.

The boxes are smeared with strong clay loam when warm, afterwards roughed with ordinary loam, and well stiffened with a pan fire, then finally struck up with finishing loam. The spindle and board are removed and the boxes dried off with a pan fire, or gas, then dressed and blacked. The allowance of loam on the boxes should not be less than $\frac{3}{4}$ in. thick.

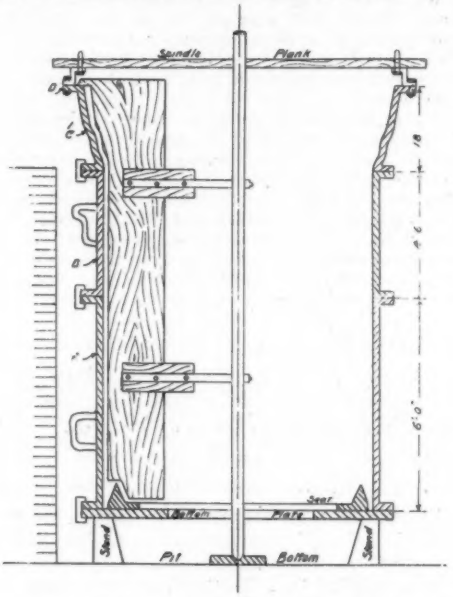

FIG 2.—POSITION OF STRIKING BOARD FOR MOULD.

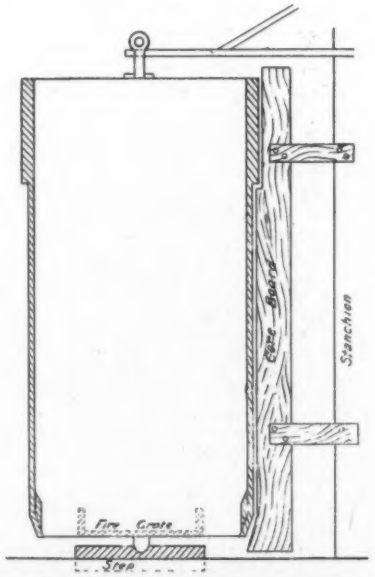

FIG. 3.—STRIKING UP THE CORE.

The core barrel (Fig. 3) has a liberating key, and is struck up vertically. A pan firegrate is fixed inside at the bottom and can be used for warming the barrel and stiffening the roughing loam. When the barrel is fixed in the bottom step and top

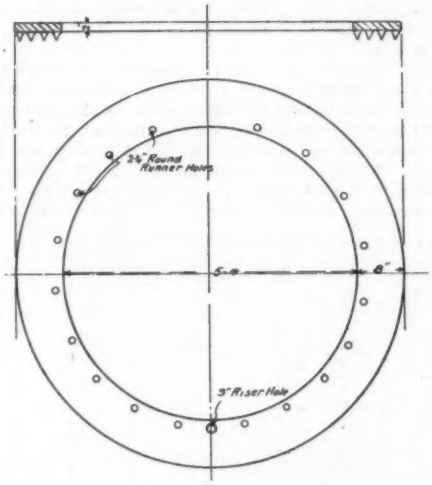

FIG. 4.—TOP CAKE PLATE.

bracket, it is smeared with strong clay loam, dried, then roughed with medium-strong loam and well stiffened before finally striking up with finishing loam. The barrel is not moved from the core-board between roughing and striking; the necessary heat for drying and stiffening will be in the barrel, im-

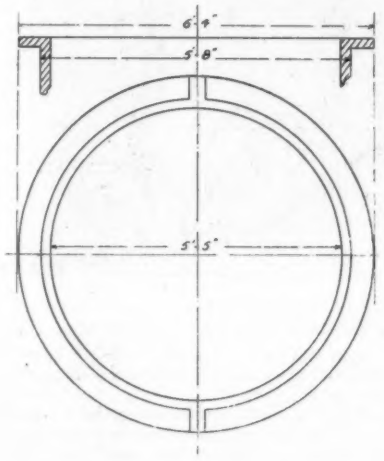

FIG. 5.—BOXES A AND B (FIG. 2).

parted to it from the casting and the pan-fire fixed inside. The core stands vertical in the stove carriage, and when dried is dressed and blacked on the carriage.

These cores can be struck up horizontally if the barrel is made suitable for that method. The amount of loam thickness on the core barrel should not be less than ¾ in. When putting the core in it is lowered into the seat, and finally centred with iron wedges from the seat ring flange (Fig. 6).

The top cake plate which closes the mould (shown in Fig. 4) is lowered over the body core and cramped to the top flange of the top box (see Fig. 1). Runners

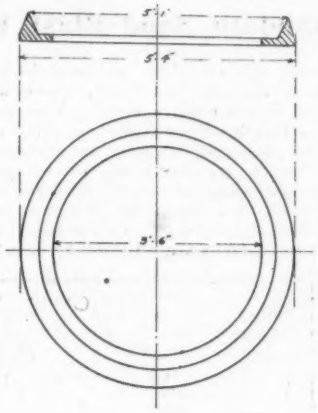

FIG. 6.—CORE SEAT.

14 to 20, 1 in. round, and one 2 in. round riser, should be sufficient for pouring, for which provision is made in the cake plate. The runner box should

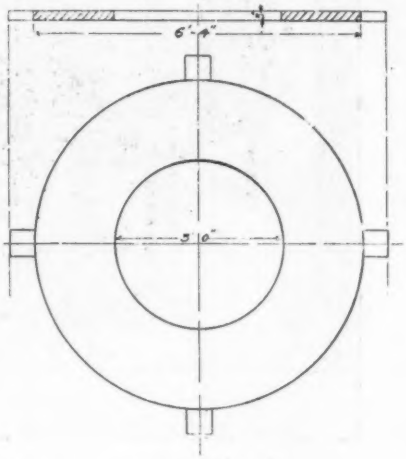

FIG. 7.—BOTTOM PLATE.

be about 6 in. deep, and feeding rods in all cases should be used to ensure soundness.

MR. H. GIELGUD, of 7a, Laurence Pountney Hill, London, E.C., has transferred the agency the Société Anonyme des Acieries d' Angleur of Tilleur, Belgium, to Messrs. Andrew Brown & Company, and the business of the agency will be carried on by that firm at the same address. He has also transferred to Messrs. Andrew Brown & Company, the goodwill of his iron and steel merchant business, established in 1866, which will be carried on henceforth by Messrs. Brown, under the style of Andrew Brown & Company, H. Gielgud's successors.

Foundry Plant and Equipment.

The Standard Sand-Blast Barrel.

In our issue of June, 1911, we published a brief description of a sand-blast barrel which was somewhat unique in its construction. This apparatus, which has met with very considerable approval in the United States, under the name of the "New Haven" sand-blast barrel, is now being introduced to the English market. Several unique features have been developed in it, but the most prominent are those which admit of its carrying within itself the sand-hopper, air-header, and sand-nozzles, as well as an automatic sand-lift. The effect of this is that when the door has been shut and the barrel put in operation, it becomes a closed revolving chamber, inside of which the sand-blasting process proceeds automatically, without a particle of dust escaping.

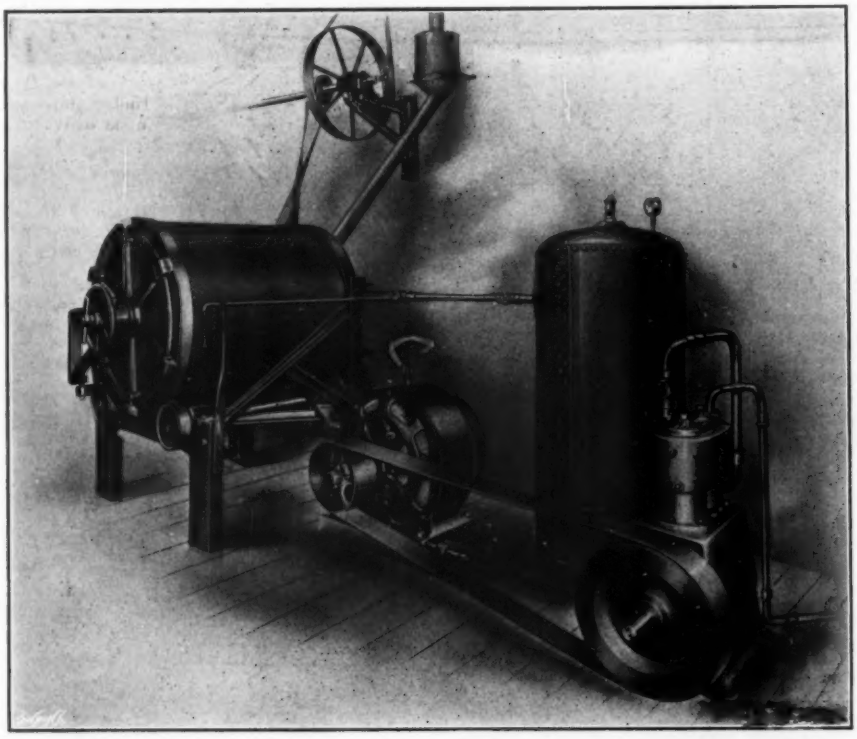

FIG. 1.—INSTALLATION OF THE "STANDARD" SAND-BLAST BARREL.

The difficulty of placing the sand-hopper, air-header, and sand-nozzles inside the barrel has been overcome by making its inner end, or head, stationary. This stationary head sustains the weight of these parts, as shown in the illustration, Fig. 1. The automatic sand-lift is managed by constructing the barrel with a double shell, the inner shell being perforated to allow the blasting material, after doing its work on the castings, to fall through it as the barrel slowly revolves, into the space between the two shells. Here it is collected by buckets and carried to the top of the barrel, where it falls back into the sand-hopper ready for re-use. This process goes on indefinitely, until the blasting material becomes dust, and is carried away by the exhaust.

As a result of these devices, no sand hose is required. High- or low-pressure blast may be made use of. In some cases a charge of from 3 to 5 cwts can be cleaned in less than 10 minutes, while in the ordinary case 10 to 20 minutes will prove sufficient, according to the pressure used and the amount of surface on the castings. The speed of the barrel is usually adjusted at from 3 to 5 revolutions per minute, at which slow speed breakage and the rounding of edges so liable to take place in the old-fashioned rumbling barrel doing about 40 turns a minute, are reduced to a minimum, or altogether obviated.

There is no expense in installing the "Standard" barrel, as it is an independent apparatus, merely requiring to be set down on a firm floor, and connected up to drive and air pressure. In operating, the castings are placed in the barrel as usual, along with a sufficient quantity of blasting material, which may be either steel shot, ordinary blasting sand, or iron sand. It is not, however, necessary to put in a complete new charge of blasting material with every lot of castings, for, as has already been explained, there will generally be sufficient left inside, after the work has been taken out, for use on other castings to follow, though a proportion must occasionally be added.

The barrel is operated from the front by three levers; starting, sand, and air levers, all being within easy reach of the operator. Castings in the process of being cleaned tumble in the barrel at right angles to the sand-nozzles at all times, thus receiving the

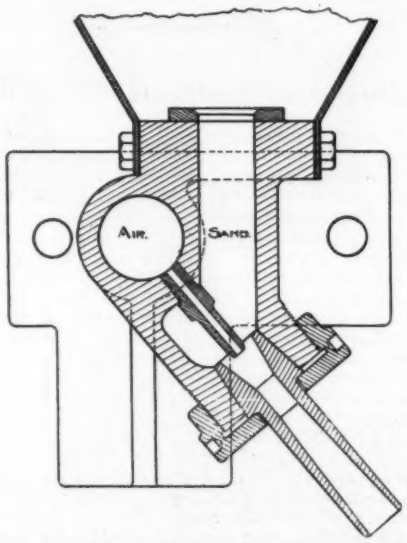

FIG. 2.—DETAIL SECTION OF SAND AND AIR NOZZLE OF THE "STANDARD" SAND-BLAST BARREL.

full force of the sand-blast, and at the same time protecting the inner shell from it. The barrel can be charged or emptied in less than a minute.

Fig. 1 illustrates a complete plant, and shows the barrel, air compressor, air receiver, electric motor, and exhaust. This installation is shown, not as an ideal arrangement of the plant, but to illustrate the absolute freedom from dust obtained with this machine. An open-type electric motor could, of course, not be run in such close proximity to the apparatus unless it was dust-free.

The apparatus is manufactured and sold by Messrs. Peter Hooker, Limited, Blackhorse Lane, Walthamstow, London, E., for the Standard Sand-Blast Machine Company, Limited, Kingsway House, Kingsway, London, W.C.

The Kerpely Gas Producer.

In view of the extensive use in steel works during the last few years of producer gas for power-plant operation, as well as for steel making, a description of a gas producer which has met with considerable approval will probably be interesting to our readers.

The Kerpely gas producer embodies several important features in its construction, the chief of which are:—(1) The revolving mechanical grate and water-cooled jacket; (2) the automatic ash discharge; and (3) the duplex air supply. Reference to Fig. 1 will show the general construction of the producer.

The revolving mechanical grate consists of a single oblong and spherically shaped cone fixed eccentrically upon the water trough and provided with a nearly flat oblong-shaped top. This cone comprises a number of plates, as shown in Fig. 1. Through the holes, the spaces between which are never choked up with ashes, the air and steam reach the producer, and the supply is under the complete control of the operator; owing to the grate revolving continuously, the supply of air and steam is dispersed over the whole area of the fuel bed in the most efficient manner. The object of the nearly flat top is to keep the CO_2 zone as low as possible—a very important feature, which will be readily appreciated by gas producer users.

The shape in plan of the grate also merits special consideration, and has been adopted after considerable experience with the practical working of other shaped grates, such as the circular placed eccentrically and the star-shaped grates. The Kerpely grate has a continuous, and not an intermittent action, in crushing any formation of clinker that may exist, instead of being continually in compression and torsion with the walls of the producer.

The effect of the water-cooled jacket will be readily understood, it being a well-known fact that no clinkers can cling to the water-cooled plates. In the Kerpely producer water is kept continuously circulating through the jacket; the heat absorbed by this cooling water amounts to a very small percentage of the heating value of the fuel gasified, and the hot water from the producer can be utilised for feeding boilers, or for other purposes.

It is well known that clinkers adhere to the brick lining of a producer, especially when the fuel being gasified is of a caking description, and in order to destroy such clinkers an excessive amount of poking and steam is necessary. The excessive poking means additional labour on the producer, and the excessive steam causes an excess of hydrogen and humidity in the gas, which is most deleterious to the furnace linings. The water jacket on the Kerpely producer overcomes this difficulty, even with strongly caking fuels, the

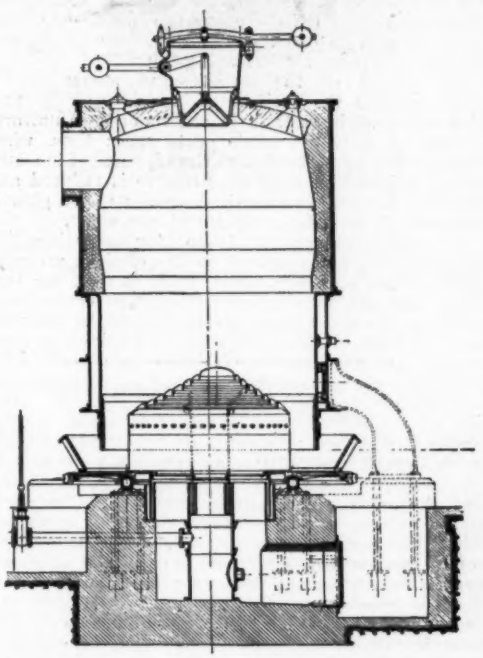

FIG. 1.—SECTION OF THE KERPELY GAS PRODUCER.

clinker being automatically disintegrated into small nodules by contact with the cooled surface of the water jacket; this fact ensures the perfect distribution of steam and air to the whole fuel bed.

The ashes accumulated in the bottom are automatically discharged by coming up against a scraper, and by regulating this scraper the ash discharge is adjusted to suit the fuel, the grate being in continuous rotation in order to loosen the fuel bed. The slow speed at which the grate is rotated—one revolution in every 2½ to 4 hours requires only a small amount of power, not exceeding 2 h.p.

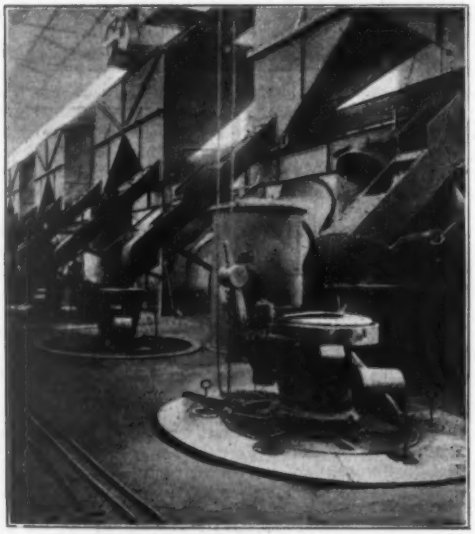

FIG. 2.—CHARGING STAGE OF KERPELY GAS PRODUCERS.

The object of the duplex and steam supply is to regulate the gasification, which in large producers is most important, in order to secure uniform combustion over the whole grate area; thus, when the producer works too hot at the edge and is too dark in the middle, the outer air pressure is reduced and the inner air pressure is raised, until an even glow is produced all over the surface, and *vice versa*.

As regards the cost of labour for operating this producer, this is dependent on the efficient arrangement of the accessory plant, such as that for coal supply and ash removal, and it must of course vary according to the nature of the fuel to be gasified, that is to say, whether the fuel is of coking or non-coking nature. Thus, for instance, in a certain installation, where free-burning fuel is gasified, and the fuel and the ash delivery are both automatic, two men have been found to be amply sufficient for the service of eight gas producers; and, in another installation, where twenty-two producers are at work, all with ordinary hoppers, the coal being delivered into same by means of overhead cranes from bunkers by the side of the installation, the ashes being removed by the same cranes from one continuous bunker and loaded into small wagons, the following staff per shift is employed, viz.: One foreman, two chargers, two crane drivers, and one labourer to clean and lubricate the driving mechanism. The plant is capable of gasifying 450 tons of coal per 24 hours. In another installation, where highly clinkering fuel is gasified, as much as one man for each producer is required.

Thus it will be seen that the labour bill must vary with each installation, according to the local conditions, but is obvious that labour must be saved with the Kerpely producer owing to its general freedom from clinkers, and its automatic discharge of ash. The cost of repairs is said to be exceptionally low. The makers of the plant in question are Messrs. E. G. Appleby & Company, 10, Victoria Street, London, S.W.

Adjustable Moulding Machine.

It is scarcely necessary to emphasise the advantages that machine moulding possesses over hand work. Apart from the greatly increased output, which incidentally means a corresponding reduction in productive cost, machine-moulded castings possess greater uniformity and superior finish. Such castings, if made from first-class patterns and with accurate moulding boxes, require practically no chipping and filing. On a machine the pattern is drawn perfectly true and in some cases, owing to the greater uniformity of the castings, the saving of metal alone warrants the laying down of moulding machines.

The machine illustrated herewith, of which the manufacturers are the Adjustable Moulding Machine Company, West Orchard Works, Coventry, is of the simplest possible nature, with absolutely nothing to get out of order. The machine is made for hand-ramming and can be used with any existing pattern-plates and boxes and has many points which should render it a valuable acquisition to the foundry. Strictly speaking, the apparatus should be described as a drawing machine, seeing that the ramming is done by hand; the cost of moulding, however, is mainly dependent upon the accuracy of the drawing, for whilst a labourer or youth can ram a mould quickly, it requires an experienced workman for sleeking, patching, or mending the moulds. There is also a saving in patterns, as a wood pattern on a hand-rammed moulding machine will last considerably longer than if used for hand-moulding.

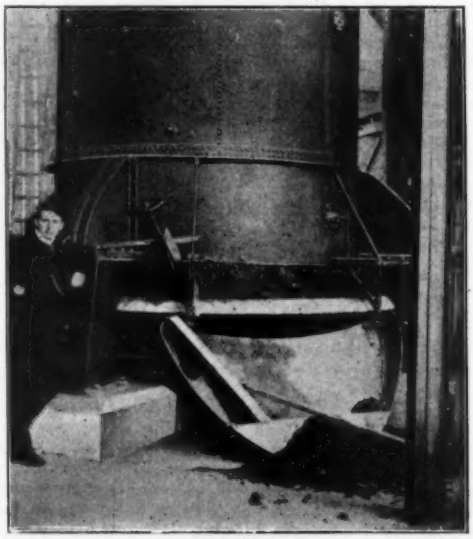

FIG. 3.—AUTOMATIC ASH DISCHARGE OF KERPELY GAS PRODUCER.

The machine illustrated requires but little description. It consists of a single pedestal, on which are

mounted two fixed arms, similar to a lathe "V" bed. Upon these arms are two sliding columns which carry the moulding boxes and can be instantly moved

FIG. 1.—ADJUSTABLE MACHINE WITH 24 IN. PATTERN-PLATE IN RAMMING POSITION.

to take any size of pattern plate from 8-in. to 24 in. wide and of unlimited length, which can be locked in any position by an eccentric.

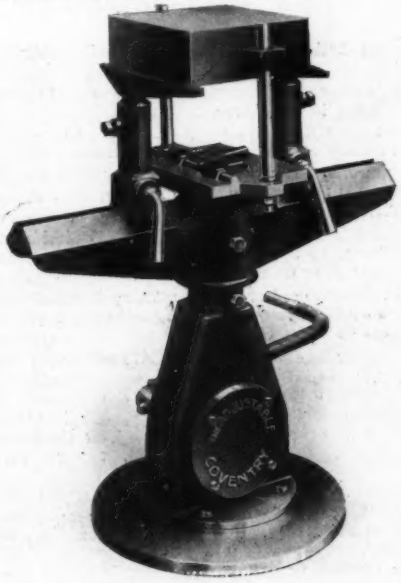

FIG. 2.—ADJUSTABLE MACHINE WITH 8-IN. PATTERN-PLATE; PLATE DRAWN, LEAVING FINISHED MOULD IN BOX ABOVE.

The columns are in turn fitted with rests for carrying the moulding boxes, which can be adjusted to suit any different thicknesses and makes of pattern plates. The pattern plates are fixed directly, or indirectly, on a table, in the centre of which is a strong plunger, which serves to support the plate and takes all the pressure of the ramming. The plunger is operated from below with a crank and central thrust connecting rod, which enables the pattern to be drawn from the mould in a perfectly true, smooth and accurate

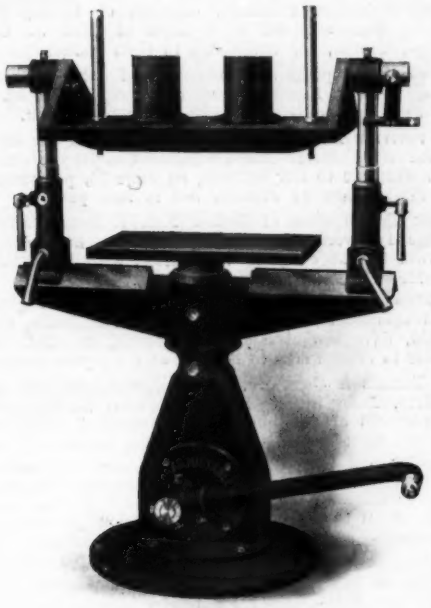

FIG. 3.—ADJUSTABLE MACHINE FITTED WITH TURN-OVER TABLE AND PLATE ON RAM TO RECEIVE LOWER MOULDING BOX WHEN TURNED OVER.

manner. All the working parts being enclosed, are protected from any evil effects of the foundry sand.

American Founders' Week.

Preparations are being made for the exhibit of foundry equipment and supplies to be held in the Broadway Exposition Building, Buffalo, during Founders' Week in that city, beginning Monday, September 23. Concurrent with this exhibit will be held the annual conventions of the American Foundrymen's Association, the American Institute of Metals and the Associated Foundry Foremen. The reconstruction of the Exposition Building has been practically completed, and an unusually large number of applications for space already has been received. At the meetings of the American Foundrymen's Association, which will be held at the Hotel Statler, on Tuesday, Wednesday and Thursday, September 24, 25 and 26, the Papers which will be read will prove unusually interesting, particularly to steel and malleable foundrymen. An exhaustive report on moulding sand tests will be submitted. The investigations of this problem have shown that widely varying results are obtained with sand in various foundries, which is due, undoubtedly, to the low cost of sand in such foundry districts, and the consequent inattention to sand economy.

Trade Talk.

THE EXCELSIOR FOUNDRY COMPANY are removing to Dudley Port.

THE liquidator of the Armadale Iron Company intimates that he will shortly pay a first and final dividend.

MESSRS. MOSS & CLATWORTHY have acquired the business of Messrs. Ford Brothers & Company, ironfounders and engineers, of Wellington, Somerset.

THE HORSELEY COMPANY, LIMITED, of Dudley Port, Tipton, have acquired three acres of land at Great Bridge, Tipton, for extensions to their works.

THE works, plant and machinery of John & Edward Wood, Victoria Foundry, Garside Street, Bolton, Lancs., will shortly be offered for sale by public auction.

A PETITION for confirming the reduction of the capital of the Bede Metal and Chemical Company, Limited, from £115,360 to £57,280 was, on June 15, presented to the High Court of Justice, and is now pending.

THE shareholders of James Neil & Sons, Limited, Grange Ironworks, Shettleston, Glasgow, have decided to wind up the company voluntarily, with Mr. J. Neil and Mr. H. Muir as liquidators.

MESSRS. MARKHAM & COMPANY, LIMITED, engineers and ironfounders, of the Broad Oaks Ironworks, Chesterfield, have bought land at Doncaster, on which they propose to erect works to be utilised for repair purposes.

S. BRIGGS & COMPANY, LIMITED, engineers and ironfounders, Moor Street, Burton-on-Trent, have acquired the goodwill of the business of Buxton & Thorneley, Limited, Waterloo Engineering Works, Burton-on-Trent.

THE CAST IRON BRAZING AND ENGINEERING COMPANY, carrying on business at 105, Bishop Street, Anderston, Glasgow, has been dissolved as at July 1, by the retiral of Mr. J. H. Inglis. The business is being continued at the same address by the remaining partner.

MESSRS. C. H. TAYLOR, J. TAYLOR, and W. TAYLOR, carrying on business as ironfounders at Sandiacre, Derby, and at 26, Derby Road, Nottingham, under the style of Taylor Bros., have dissolved partnership. Debts by C. H. Taylor and J. Taylor, who will continue the business.

JOHN LYSAGHT, LIMITED, who, during the past two or three years have been erecting new steel works at Scunthorpe, Lincolnshire, have during the month got two of their blast furnaces into operation, and very shortly they expect to have their steel-making furnaces at work as well.

THE partnership heretofore subsisting between Messrs. A. E. Seymour and J. Skidmore, carrying on business as brassfounders at 91, Bridge Street West, Birmingham, under the style of Brown & Seymour, has been dissolved. Mr. A. E. Seymour will continue to carry on the business under the same name.

DAVID COLVILLE & SONS, LIMITED, of the Dalzell Steel and Iron Works, Motherwell, are at present engaged upon extensive additions to their plant and works, which when completed will, it is stated, increase the output very materially. Several acres of ground have been taken in, and new melting furnaces are to be erected.

THE umpires appointed to decide in the case of the Sheffield moulders' dispute whether work which had been given to moulders should now be given to coremakers, because of the wider use of core methods, have given a decision in favour of the moulders, whose wages are about 6s. per week more than those of the coremakers.

THE foundry and engineering shop formerly belonging to John Dick & Company, Limited, Clifton Iron Foundry, Coatbridge, was sold by public roup on August 20 at the upset price of £1,100. The name of the buyers was not disclosed, but it is understood that the works, which have been closed for two or three years, will be reopened at an early date. The works gave employment to between 200 and 300 men.

AT the expiration of three months the names of the undermentioned companies will, unless cause is shown to the contrary, be struck off the Register of Joint Stock Companies, and the companies will be dissolved :—Aston Cantlow Mill Ball and Bearing Company, Limited; Dougill's Engineering, Limited; J. T. Petford, Limited; and Reform Castings, Limited. The name of the Sandy Mount Foundry Company, Limited, has been struck off the Register.

THE SANDYCROFT FOUNDRY COMPANY, LIMITED, of Sandycroft, near Chester, inform us that in future the title of their firm will be Sandycroft, Limited. This alteration has been made owing to the confusion of ideas resulting from the use of the title, Sandycroft Foundry Company. There has been an impression amongst those who do not know the company's works that they were makers of iron castings and heavy engineering work only. As a matter of fact, they have been making electrical machinery, starters, motors, and generators, both D.C. and A.C., for the past twelve years.

THE first meeting of the members of the Association of Consulting Engineers was held recently, Mr. G. M. Taylor presiding. After some discussion, the following alterations were made in the rules of the Association :—That the subscription be raised from one guinea to two guineas; corporate membership of the Institution of Civil Engineers, or full membership of the Institutions of Electrical or Mechanical Engineers be accepted as evidence of technical qualification for membership of the Association; that members be entitled and requested to use the abbreviation M.Cons.E. when stating their qualifications; that the committee be increased to 18, of whom not more than 12 shall be London members. With regard to the latter part of the last rule, the following were elected the London members of the committee :—J. S. Alford, H. P. Boulnois, W. T. Douglass, B. Latham, E. L. Mansergh, W. M. Mordey, W. H. Patchell, H. Rofe, J. F. C. Snell, E. H. Stevenson, J Swinburne, and G. Midgley Taylor.

New Companies.

TUNGSTEN & ALLOYS, LIMITED.—Capital £2,000 in £1 shares.

RAMSAY'S MARINE ENGINEERING COMPANY, LIMITED.—Capital £1,000 in 1s. shares.

ASQUITH BROTHERS, LIMITED.—Capital £4,500 in £1 shares, to carry on the business of machine makers.

Z. W. ONIONS, LIMITED.—Capital £10,000 in £1 shares (2,500 pref.), to carry on the business of iron manufacturers, etc.

CALLENDAR IRON COMPANY, LIMITED.—Capital £85,000 in £10 shares, to acquire and carry on the business of the Callendar Iron Company, Falkirk.

J. & R. HOUSTON & KERR, LIMITED.—Capital £5,000 in £1 shares, to acquire the ironfounding and engineering business of J. & R. Houston, Limited, Greenock.

H. MUNZING, LIMITED.—Capital, £75,000 in £1 shares (70,000 pref.), to carry on the business of ironfounders. Registered office: 90-96, Union Street, Southwark, S.E.

E. A. REED & COMPANY, LIMITED.—Capital £2,000 in £1 shares (1,000 preference), to carry on the business of ironfounders. Registered office: 14, Victoria Street, S.W.

G. LEWIS & SON, LIMITED.—Capital, £5,000, in £1 shares (2,000 pref.), to carry on the business of manufacturers of machinery, iron and brassfounders, metal workers, etc.

GEORGE ROBERTSON & SONS, LIMITED.—Capital £10,000 in £1 shares, to acquire and carry on the business of brass founders, metal workers, and engineers. Address: Snawdoun Works, Paisley.

PHILLIPS & DAY, LIMITED.—Capital, £2,000, in £1 shares, to acquire the business of a general brassfounder carried on by G. H. Jones (trading as Phillips & Day) at 30, Darwin Street, Birmingham. Registered office, 30, Darwin Street, Birmingham.

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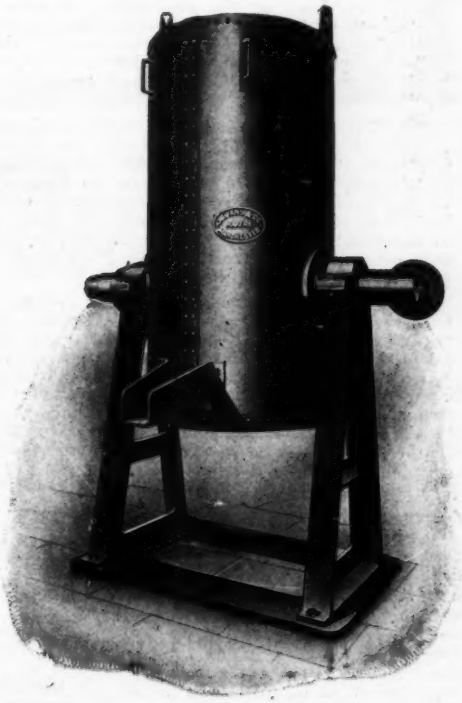


James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Deaths.

THE death is announced of Mr. Wm. Jackson, J.P., engineer, of the Derdale Iron Works, Todmorden, aged 65 years.

MR. WILLIAM YATES, one of the directors of the engineering firm of Yates & Thom, Limited, Blackburn, died recently. Mr. Yates was 52 years of age.

THE death took place on August 10 of Mr. Josiah Brookes. Mr. Brookes, who was sixty-six years of age, was senior member of the firm of Messrs. J. & H. Brookes, bedstead manufacturers, Smethwick.

THE death is announced from Wassy (Haute Marne), France, of M. Auguste Bedet, joint managing director of the Compagnie des Forges de Champagne et du Canal de Saint-Dizier à Wassy.

EX-PROVOST KEITH, of Arbroath, died recently at the age of 89 years. He started the Arbroath High Street Foundry, a business which has since been immensely extended by his eldest son, Mr. James Keith, who is a partner of the firm of James Keith & Blackman Company, Limited, of London, Edinburgh and Arbroath.

THE death took place recently at the age of 63 at Cross Hills of Mr. John P. Wolfenden, who for some time was a partner in the firm of Varley & Wolfenden, ironfounders, Cyclops Works, Keighley. Later, Mr. Wolfenden started on his own account at Standard Works, Cross Hills. About four years ago he gave up business.

THE death has occurred suddenly of Engineer Rear-Admiral J. T. Corner, C.B. The deceased officer had a distinguished career as a naval engineer, and was for many years head of the engineering department of Portsmouth Dockyard, retiring three years ago. He was a director of Argylls, Limited, the British Niclausse Boiler Company, Limited, Brown Brothers & Company, Limited, and Bull's Metal and Melloid Company, Limited.

MR. WILLIAM BAYLEY MARSHALL, of Birmingham, died recently at the age of 61. In 1868 he was apprenticed to Messrs. Dubs & Company, locomotive engine builders, at Glasgow, and in 1873 he entered the drawing office of Messrs. Robert Napier & Sons, marine engineers. In 1878 he was appointed general manager and secretary to the Staffordshire Wheel and Axle Company, and in 1882 entered into partnership with his father in the profession of consulting engineer.

THE death took place on July 29, at his residence at 6, Great Stuart Street, Edinburgh, of Mr. Thomas Templeton Mackie Lumsden, managing director of the firm of James Milne & Son, Limited, Milton House Works. Mr. Lumsden, who was a native of Edinburgh, was at the commencement of his business career connected with the firm of Bertrams, Limited, Sciennes, Edinburgh. He joined the firm of James Milne & Son, Limited, twenty-four years ago, and for some eighteen years occupied the position of managing director. Mr. Lumsden was sixty-two years of age.

Personal.

The name of Mr. T. W. Ward, of T. W. Ward, Limited, Sheffield, has been added to the Commission of the Peace for the city.

THE late Mr. W. J. Fraser, formerly of W. J. Fraser & Company, Limited, engineers, 98, Commercial Road, London, E., left estate valued at £10,443.

THE late Mr. F. Dyson, of Fredk. Dyson & Sons, Limited, ironfounders, of Leeds, left estate valued at £7,662 gross, and £7,395 net personalty.

THE late Mr. A. P. Firth, J.P., well known in the Leeds iron trade, left estate of the gross value of £26,429, of which £24,485 is net personalty.

THE gross value of the estate of the late Mr. R. Blakeborough, of J. Blakeborough & Sons, Woodhouse Ironworks, Brighouse, is £38,505, of which £37,147 is net personalty.

THE late Mr. A. C. Rudolf de Wette, a director of the New Expanded Metal Company, Limited, left unsettled property of the gross value of £23,116, of which £20,118 is net personalty.

SIR JOHN S. RANDLES, chairman of the Workington Iron and Steel Company, Limited, has been returned for North-West Manchester, which seat was resigned by Sir George Kemp.

MR. SHERARD COOPER-COLES has been awarded the John Scott Legacy Medal and Premium by the Franklin Institute, Pa., U.S.A., in recognition of his Sherardising process.

MR. G. D. SEATON has, we understand, joined the staff of Richardsons, Westgarth & Company, Limited, and will represent them in the Manchester district, where he will act as sales agent for their land specialities.

THE late Mr. J. H. Wilkinson, director and works manager of W. Cooke & Company, Limited, of Tinsley, Sheffield, left estate of the gross value of £3,558, of which £2,766 is net personalty.

MR. WILLIAM LONGDON, of Derby, for 52 years with A. Handyside & Company, Limited, of the Britannia Ironworks, Derby, who died on June 19 last, aged 74 years, left estate of the gross value of £2,774 10s. 4d., with net personalty £2,365 1s. 10d.

MR. GEORGE M. PARK is retiring from the active managing directorship of the engineering firm of Ashton, Frost & Company, Limited, Blackburn, after holding that position for twenty-one years, but will continue to be a director of the company.

THE late Mr. Richard Pratt, of Danby House, North Ormesby, near Middlesbrough, manager to Cochrane & Company, Limited (Cochrane Grove Branch), Ormesby Ironworks, Cargo Fleet, Middlesbrough, left estate valued at £8,378 4s. 9d., including net personalty £3,483 3s. 7d.

IT is stated that Mr. J. W. Summers, the head of the firm of Messrs. John Summers & Sons, Limited, of Queensferry and Shotton, who is Liberal Member of Parliament for Flint County, is to be offered a peerage in recognition of the valued services he has rendered to his party.

MOULDERS' SAND should be passed over a Rapid Electro Magnetic Separator to recover the Iron, much of which is now waste

Magnetic Separators to remove Iron from Brass Turnings, etc,

without waste.

The Rapid Magnetting Machine Co., Ltd.,

OF BIRMINGHAM.

Telegrams: "Borings, Birmingham"
Phone: Central 1842.

On War Office List.

PURE METALS

and ALLOYS. FREE from CARBON.

TITANIUM THERMIT

for

SOUND. STRONG, CLOSE-GRAINED CASTINGS.

Also FERRO VANADIUM and FERRO TITANIUM.

Full Particulars and PRICES from—

THERMIT LIMITED

Telegrams: "Fulmen, London."
Telephone: 3749 Central,

27, Martins Lane, Cannon Street, E.C.

Works: 210a, Bow Road, E.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	End Aug., 1912.	End Aug., 1911.
Iron—Scotch pig warrants ton	*69/3	*53/0
—Middlesbro' warrants . ton	63/8	46/11
—W.C. M/nos Bessemer ... ton	79/6	64/0
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chili bars GMB ton	£78 18 9	£56 2 6
—Stock, Europe and afloat tons	—	—
Tin—English ingots ... ton	£214 10 0	£192 10 0
—Straits ... ... ton	£212 0 0	£189 15 0
—Stock, London, Holland, U.S.A., and afloat ...tons	—	—
Lead—English pig ... ton	£21 0 0	£14 12 6
Spelter—Ord. Silesian ... ton	£26 10 0	£27 15 0
Quicksilver (75lb)... bottle	£7 15 0	£9 0 0
Antimony—Regulus ... ton	£28 0 0 £29 0 0	£28 5 0
Aluminium—Ingot ... ton	£80 0 0	—

* Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 12 6	to	6 0 0
,, 3 to 4 in.	5 7 6	to	5 10 0
,, 5 to 8 in.	5 5 0	to	5 7 6
,, 10 to 16 in.	5 5 0	to	5 7 6
,, 18 to 24 in.	5 5 0	to	5 7 6
Chairs	3 17 6	to	4 0 0
Floor plates (open sand)	3 10 0	to	3 12 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 5s. 0d. ; heavy cast, £2 10s. 0d. ; all per ton, f.o.b., London. Copper (clean), £70 10s. 0d. ; brass (clean), £45 10s. 0d.; lead (usual draft), £17 15s. 0d.; Zinc, £20 10s. 0d.; all per ton delivered merchant's yard.

Parliamentary Item.

Old Metal Dealers Bill.

The object of the Bill is to prevent a large amount of theft of brass and other expensive metals (including precious metals) by providing that all persons melting metal or metal goods shall be licensed by a court of summary jurisdiction, and by certain provisions which will enable metal or metal goods reasonably suspected to have been stolen or illegally obtained, to be seized and dealt with before they can be melted down and their identity entirely destroyed. The provisions of the Bill are such as will not interfere in any way with the ordinary trade transactions or the liberty of individuals to deal with metal and metal goods honestly obtained.

CUPOLA BRICKS
FOR LINING
ORDINARY AND PATENT
CUPOLA FURNACES.
JOHN R. FYFE & Co.,
SHIPLEY, Yorks.

BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.
Sole manufacturers—
RUDD & OWEN
(DEPT. I)
Telegrams "Therpinene" Hull.
HULL
Telephone National 1223

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams : "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

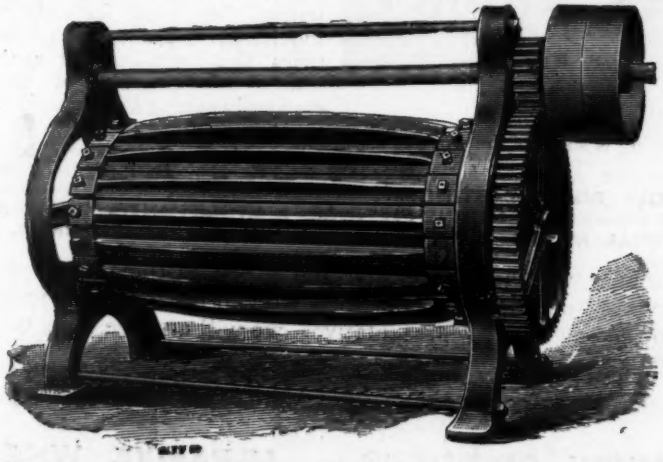
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Plate Moulding with Snap Flasks . .

is used extensively for dealing with light castings in all departments of the foundry trade. It is without question a very rapid method of moulding, and taken in conjunction with the fact that the snap flask does away with moulding boxes it is not surprising that the system is growing in favour. In point of output many power Moulding Machines can show an advantage over plate moulding, but this is over-balanced by the cost of the necessary boxes, the maintenance expenses and the floor space required for storing them.

¶ In our **BOXLESS HYDRAULIC MOULDING MACHINE** we have the snap flask or boxless system combined with a power ramming moulding machine. It is the most complete machine in existence, for it rams both halves of the mould simultaneously, draws the pattern, cuts the runner and gates, closes the mould, and delivers it ready for receiving the metal. ¶ As both halves of the mould are made simultaneously and compressed to an equal extent, much truer and better castings result than when each half is made separately. Correctly located pins and holes in the moulding boxes and pattern frames ensure accurate closing and prevent overshut castings.

¶ The rate of production is such that no man with a plate and a snap flask can possibly compete. 200 moulds a day is quite ordinary and, in some cases, the rate of production with two men amounts to 400 moulds in eight hours.

¶ One firm to whom we have supplied several of these machines is obtaining four times the output they were formerly getting by plate moulding. ¶ Another is getting two and a half times the output, whilst a third is obtaining double the quantity of moulds they were previously getting from pneumatic machines.

¶ The following is some of the work that the machine is doing :—

SEWING MACHINE ARMS. FURNACE BARS. BOILER DOORS AND FITTINGS.
STOVE PLATE CASTINGS. AIR BRICKS. BRACKETS.
COTTON AND SPINNING MACHINE FITTINGS. MANGLE PARTS. COLLIERY TUB WHEELS.
AGRICULTURAL MACHINE FITTINGS LAWN MOWER FITTINGS. ETC., ETC.

The machine will not make any and every casting, but if you will send us sample castings or drawings of your work we will tell you what it will do, or if you would like to see one of our representatives, we will arrange for a visit.

THE QUICKER YOU ACT THE SOONER WILL THE SAVING BEGIN.—WRITE TO-DAY.

With our 15 different types of Moulding Machines we cover the requirements of any foundry.

EMERY GRINDERS. ABRASIVE WHEELS.

THE LONDON EMERY WORKS Co., PARK WORKS,
TOTTENHAM, LONDON, N.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

Abrasive Wheels.
Evans, J. & Co.
London Emery Works
Jackman, J. W., & Co. Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Aluminium.
British Aluminium Co, Ltd.

Annealing.
Evans, J. & Co.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Barrels (Tumbling).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Hall, Charles, & Co.
Hooker, Peter, Ltd.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Standard Sand-Blast Machine Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
F. Braby & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co. Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co.,Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Blowers.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Dempster, R. & J., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd
Keith, J., & Blackman, Co., Ld.
London Emery Works Co.

Blowers—*cont*
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Casting Cleaners.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
Dyson, J. & J.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Lowood, J. Grayson, & Co., Ld.
Marshall & Co., Horace P.
Metalline Cement Co.
Olsen, Wm.
Plasti-Kion Co.
Rudd & Owen
Silent Machine and Eng Co.

Chaplets and Studs.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Motherwell, Wm., & Co.
Olsen, Wm.
Wilkinson, T., & Co., Ltd.

Charcoal.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Walker, I. & I.

Charging Platforms.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

Coal Dust.
Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co
Jackman, J. W., & Co., Ltd.
Mansergh, T. E.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles. & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd

Core Making Machines.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
Jones & Attwood, Ltd.
London Emery Works Co.
Phillips, J. W. & C. J.
Portway, C. & Son.

Core Ropes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Jackman, J. W., & Co., Ltd.
Ward, T. W., Ltd.

Crucibles.
Evans, J. & Co.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Derby Boiler Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Hall, Charles & Co
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onion Pneumatic Eng. Co., Ltd.
Davis, T., & Sons.
Evans, J., & Co.,
Hall, Charles & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Mitchells Emery Wheel Co.

Facings.
Evans, J. & Co.
Olsen, William

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Keith, James, & Blackman Co., Ltd
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Evans, J. & Co.
Fyfe & Co., J. R.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
Pearson, E. J. & J.

Foundry Blacking.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Olsen, Wm.
Walker, I. & I.
Wilkinson, Thos. & Co., Ltd.

Foundry Brushes.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, C., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Phillips, J. W. & C. J.

Foundry Ladles.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Derby Boiler Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
McNeil, Chas.
Phillips, J. W. & C. J.
Thwaites Bros. Ltd.

THE BUYER'S GUIDE.—*Continued.*

Foundry Rattlers or Fettling Drums.
Alldays & Onions
Davies, T., & Son
Durrans, J., & Sons
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co.
London Emery Works Co.
Marshall & Co., Horace
Phillips, J. W. & C. J.

Foundry Sand.
Standard Sand Co., Ltd.
Dyson, J. & J.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Wilkinson & Co., Thos., Ltd.
Williams, J. (Birmingham Sand), Ltd.

Foundry Specialists.
Naish & Croft.

Furnaces (Annealing).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Keith, James, & Blackman, Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Brass).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Furnaces (Melting).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Ground Gannister.
Durrans, J., & Sons.
Dyson, J. & J.
Evans, J., & Co.
Lowood, J. Grayson, & Co.
Walker, I. & I.

Grinding Machines and Tools.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Hammers (Steam).
Alldays & Onions Pneumatic Eng. Co., Ltd.
Thwaites Bros., Ltd.

Hay Band Spinning Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall &Co., Horace P.

Hoists.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Loam and Sand Mills.
Davies, T., & Son.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall & Co., Horace P.
Ward, T. W., Ltd.

Magnetic Separators.
The Rapid Magnetting Machine Co., Ltd.

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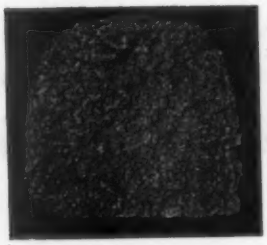
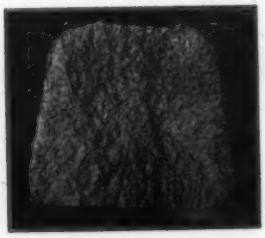
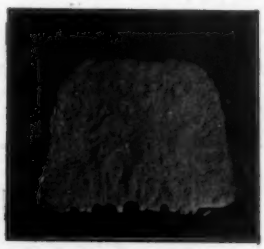

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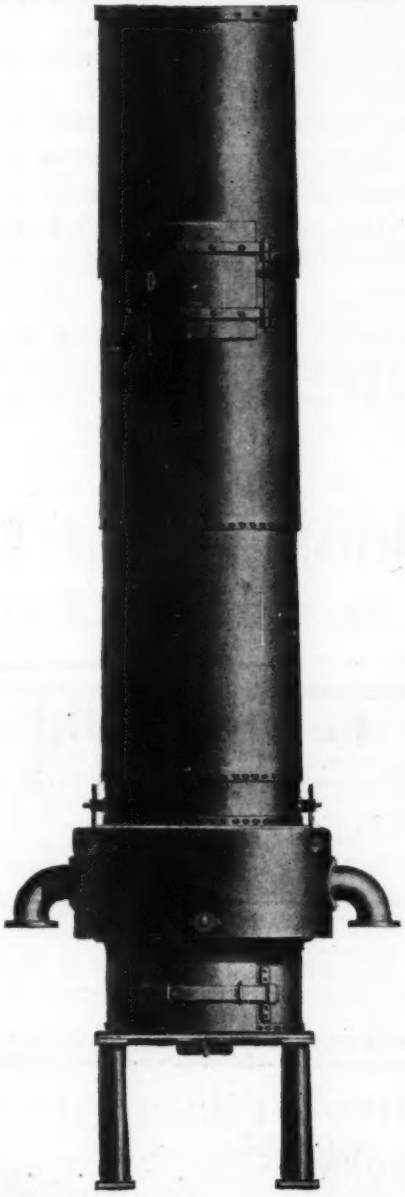

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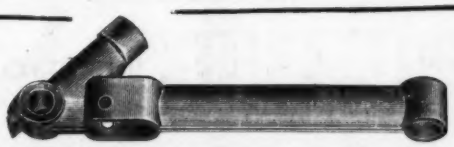

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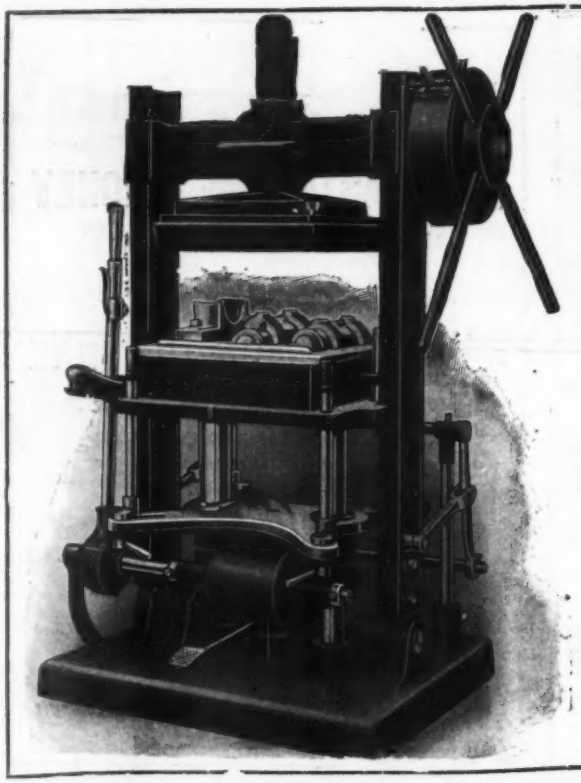

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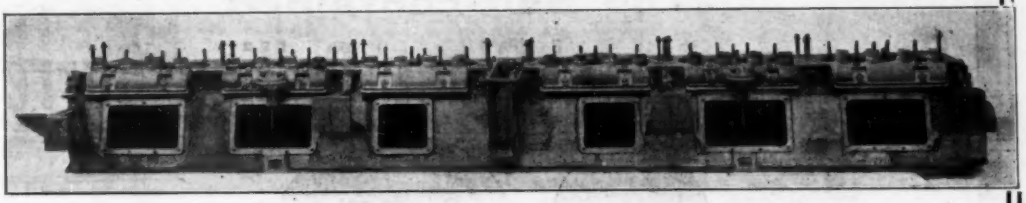

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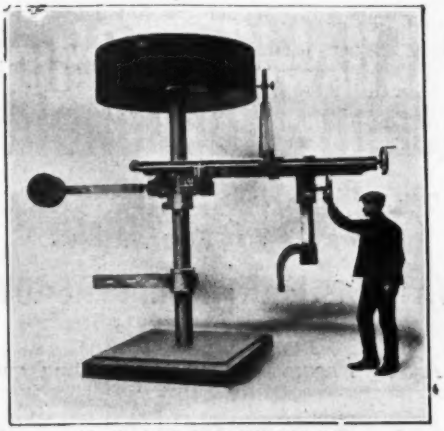

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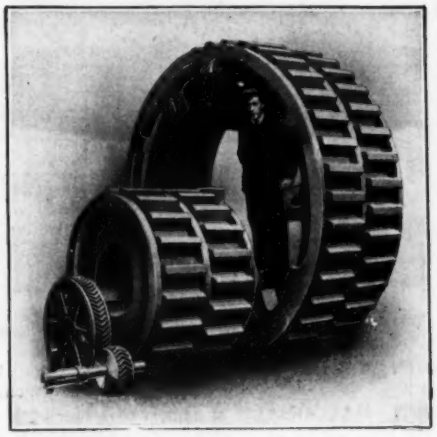

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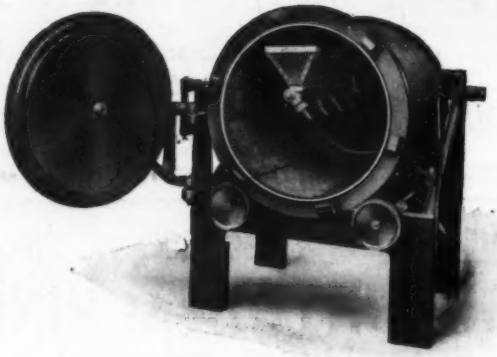

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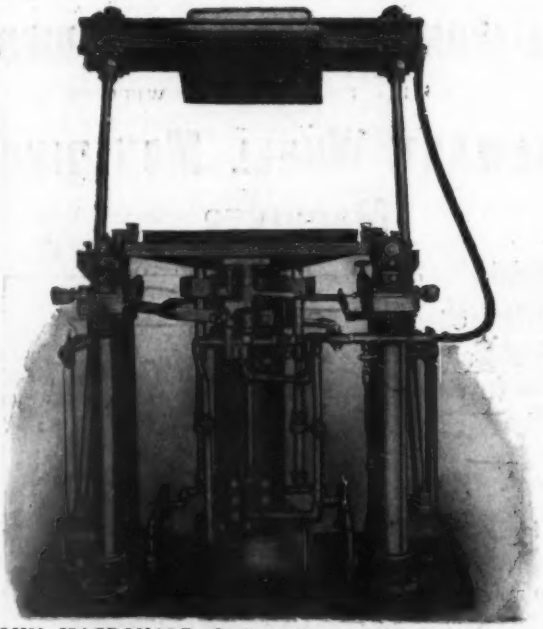

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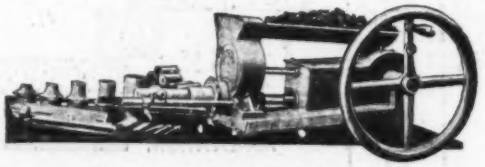

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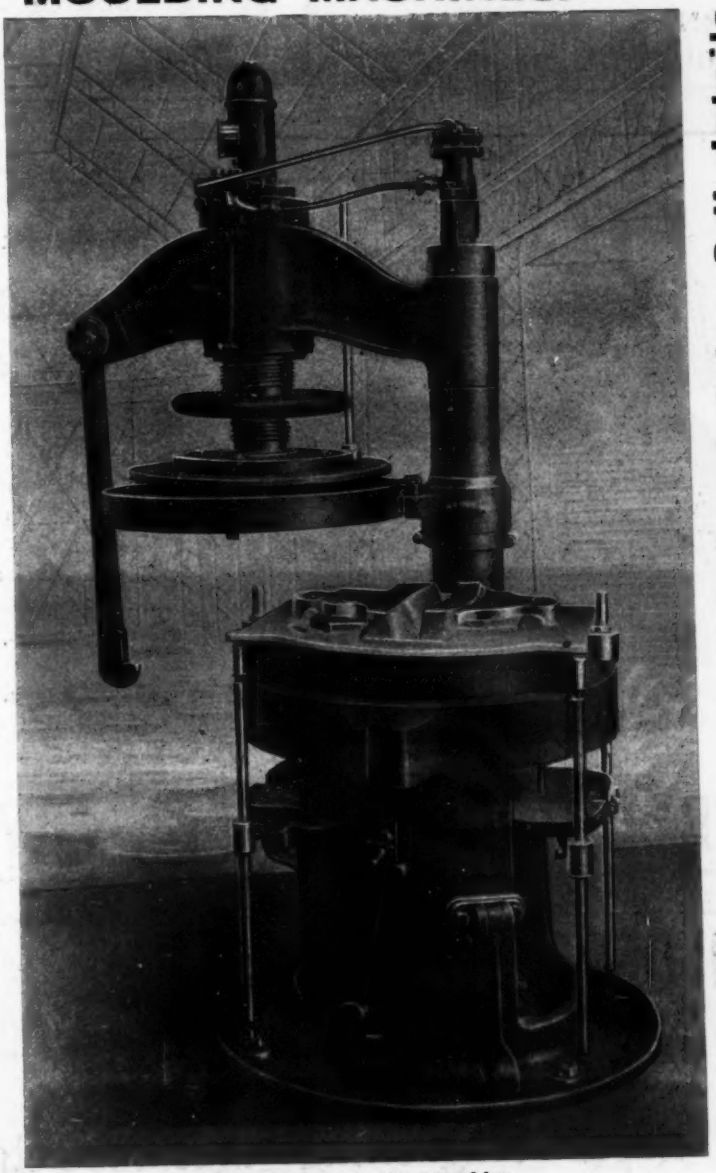

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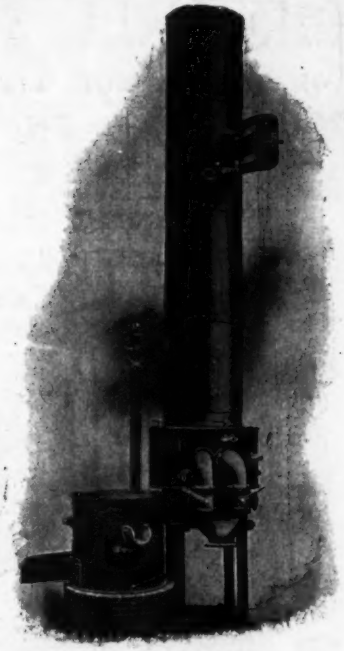

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